A

GENERAL SYSTEM

OF

CHEMICAL KNOWLEDGE,

&c. &c.

A

GENERAL SYSTEM

OF

CHEMICAL KNOWLEDGE;

AND ITS

APPLICATION

TO THE

PHENOMENA OF NATURE AND ART.

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IN ELEVEN VOLUMES,

TOGETHER WITH A SET OF SYNOPTIC TABLES, IN LARGE FOLIO.

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BY WILLIAM NICHOLSON.

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FOURTH VOLUME.

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CONTINUATION OF

SECTION FIFTH.

ARTICLE XII.

GENUS XI.

Earthy and Alkaline Carbonates.

SECTION I.

Concerning the Generic Characters of these Salts.

1. THE carbonates, or faturated combinations of the carbonic acid with earthy and alkaline bafes, are the laft genus of falts according to my arrangement; becaufe the general attraction of that acid for the bafes is the weakeft and moft eafily deftroyed. Although thefe falts are, in hiftorical order, the laft known, or the moft recently difcovered, their

properties

properties have been more deeply inveftigated, and better determined, in the thirty years during which they have been examined, than thofe of the greater part of the preceding genera; and there is no department of chemiftry of which the hiftory is more complete, exact, and luminous. They hold a rank fo much the more diftinguifhed among faline compounds, becaufe, in proportion as their properties have been difcovered, they have fuddenly brought into chemiftry a mafs of new knowledge, and have explained a great number of phenomena, that were either unknown, or ill defcribed before their difcovery. It may alfo be faid, that by deftroying many errors, uncertainties, and prejudices, refpecting the refult of moft chemical operations, the ftudy of the carbonates, and of their mutual actions, has fo greatly contributed to the progrefs of the fcience, as in reality to have given it a new afpect.

2. It is to the illuftrious Dr. Black that we owe the firft knowledge of thefe faline fubftances; confounded, before his time, with the alkalis and alkaline earths, of which we then knew neither the different ftates nor degrees of purity. This great refult of enlightened genius bears date 1756. By confidering the carbonic acid, which with Hales he named fixed air, as rendering the alkalis mild, caufing them to cryftallize, and giving them the property of effervefcing with acids, by proving the attraction of that acid to be more ftrong for lime

than

than for alkalis, and the production of caufti-
city as the neceffary confequence of its abforp-
tion by pure calcareous earth, Profeffor Black
has opened a new and immenfe career, in which
contemporary chemifts foon made great pro-
grefs, and which has prefented to them a feries
of highly important difcoveries.

Lavoifier himfelf was one of the firft engaged
in this purfuit with M. Cavendifh, between
the years 1766 and 1772; and thefe philofo-
phers, by determining the quantities of this
fugacious and volatile being, which they did
not yet venture to call an acid, both in its
difengaged and in its fixed ftate, firft gave
an example of precifion, which has been fol-
lowed in fubfequent refearches.

Chaulnes foon difcovered, in 1773, the art
of cryftallizing the alkalis, by keeping their
folutions immerfed and agitated over a veffel of
beer in fermentation, and faturating them with
the gafeous acid difengaged from the beer.

Bergmann at the fame time examined it, and
in a learned differtation concerning this new
body, which he called aërial acid, he defcribed
the properties of moft of its combinations with
alkalis.

Since the time of that able chemift nothing
more has been done than to add, by degrees,
ideas more definite and more enlarged refpecting
each of thefe falts: and the fucceffive labours
of Rouelle, of Citizen Berthollet, of Mr. Kir-
wan, of Citizen Guyton, of Pelletier, of Bayen,

of

of Meffrs. Withering, Pearfon, Tennant, and of the greater number of modern chemifts, have fo far advanced the knowledge of earthy and alkaline carbonates, that fcarcely any thing more remains to be done refpecting their hiftory ; and when we confider all the fpecies individually, there are much fewer deficiences than in the other genera.

3. The carbonates were firft termed mild and effervefcent earths or alkalis, confidering only their differences in that ftate compared with their cauftic or pure ftate. Bergmann denominated them aerated earths or alkalis, in conformity to his denomination of aërial acid. Citizen Guyton, adopting the term of mephitic acid, calls them mephites of fuch or fuch a bafe. The name of cretaceous acid which I had adopted in 1778, with Bucquet, induced us to name them earthy or alkaline chalks. But when the nature of the acid which forms them was well known, and when it was defcribed under the name of carbonic acid, the word carbonates was formed, to exprefs thefe faline combinations.

4. The greater part of the earthy and alkaline carbonates exift in nature; where they form very confiderable maffes to which the globe owes part of its ftrata and of its folidity. Some are found in lefs abundance, and occupy only certain points, or conftitute only narrow veins. It is rare that thefe falts are found much infulated and very pure, though many

are

are met with even in that ftate ; moft frequently two or three are blended together, or depofited with filex, alumine, and metallic oxides ; they rarely form any part of the primitive mountains, but are much more frequently found in the fecondary mountains, or thofe of latter formation.

5. Thofe which nature affords pure may be ufed in the experiments of chemiftry in their natural ftate ; the fame fubftances are often prepared by art, by directly uniting the carbonic acid with earthy or alkaline bafes, by receiving this gafeous acid in their folutions till they are well faturated, and till they refufe to abforb any more, or are intirely depofited or precipitated, when the character of thefe carbonates is to be infoluble. We are fure to have thefe falts very pure, when the bafes which are employed to form them are themfelves very pure, and when care is taken to combine only fuch carbonic acid as is deprived of that fmall portion of the acid which is ufed to difengage it, and is apt to rife with it. For this reafon, before it is received in the folutions of earths or alkalis intended to be faturated, it will be proper to pafs through it a fmall quantity of water in which it may depofit that portion of foreign acid.

6. Although the phyfical properties are little adapted to characterize the genera of falts, and belong much rather to the fpecies, there are

<div align="right">fome</div>

some of them which are to be found in the carbonates, and ought to be confidered generally through the whole of the fpecies. Thefe falts are moftly without tafte, or have an earthy one, and fometimes an alkaline or urinous tafte ; but even then it is weak and fupportable. Hence they were formerly called mild alkalis. All of them are capable of affuming regular forms, and there are no falts in which Nature feems more to delight, or which it is apparently more eafy to produce in polyhedral cryftals, of well-determined figures, but they are always extremely varied. The hardnefs of fome is very great, whilft others are friable, or even without aggregation. It was the folidity of the firft added to their infipidity and apparent infolubility, which caufed them to be claffed fo long amongft the earths by mineralogifts.

7. Light does not change them ; moft of them are tranfparent ; fome produce double refraction. Heat decompofes almoft all of them by fubliming their water and carbonic acid in fuch a manner as to reduce them to the ftate of pure or infulated bafes : in fact, this decompofition, though very eafy in the greater number, is extremely difficult in fome ; which depends on the various degrees of attraction of the feveral bafes for carbonic acid.

8. Oxigen and azote, neither in the gafeous nor combined ftate, have any action on the carbonates. Neither does air by its humidity

produce

produce any change in them; they are not deliquefcent; fome of them are even very efflorefcent.

9. They vary much as to the manner in which combuftible bodies affect them. Carbon frequently renders their acid more volatile, and more eafily feparated by the action of heat, without our being able to know how it produces this fingular effect. Phofphorus, ftrongly heated with the carbonates, decompofes their acid, becoming at the fame time phofphoric acid which forms phofphates with the bafes, and infulates the carbon, fo as to render the mixture black. This decompofition which does not take place with equal facility in all the carbonates, and in fome of them not at all, appears the more fingular at firft confideration, becaufe carbon, fingly and alone, decompofes the phofphoric acid, and has really more attraction for oxigen than the phofphoric acid has. To explain this phenomenon it is neceffary to ftate, that as carbon decompofes the phofphoric acid by itfelf, fo, on the other hand, phofphorus does not decompofe the infulated carbonic acid; but again, that carbon can not act on the phofphoric acid united to its bafes, and does not produce phofphorus with thefe falts, as has been feen in the characters of the genera of phofphates; and alfo that phofphorus decompofes the carbonic acid only when it is united to certain bafes, or in the ftate of carbonates. It is, therefore, to the

attraction

attraction of thefe bafes for the phofphoric acid that we muft afcribe the decompofition of the carbonic acid of carbonates by phofphorus, and the non-decompofition of phofphates by carbon. In this remarkable action may be feen an effect and inftance equally ftriking of what I have called difpofing attraction.

10. The carbonates divide themfelves into two claffes with regard to the action of water; fome are nearly infoluble, others are eafily diffolved; fome are diffolved more readily in warm than in cold water. Specific characters are derived from this property.

11. All the other acids have more attraction for the earthy and alkaline bafes than the carbonic acid; all of them, if poured upon the folid and cryftallized carbonates, caufe a lively effervefcence by the difengagement of carbonic acid, in the form of an elaftic fluid. This effervefcence, which was formerly confidered as a character of the alkalis, is only a character of the carbonates. The change of the carbonic acid, which they contained in a folid ftate, to the ftate of gas, or of an elaftic fluid, announces that it is then impregnated with caloric difengaged from the new combination of the bafes with the decompofing acids, and that this caloric is united to the carbonic acid, to which it gives the gafeous form.

Accordingly there is no heat produced during thefe decompofitions, which are accompanied by effervefcence, or a fpecies of ebullition; whereas
there

there is a very ftrong heat when thefe earthy, pure, and cauftic alkaline bafes are united to acids which faturate them without motion or the difengagement of bubbles.

12. This decompofition of the carbonates by the nitric, muriatic, or fulphuric acids, is ufed for collecting the carbonic acid in the gafeous form. It is performed in glafs bottles, with re-curved tubes, which conduct the gas under bell-glaffes full of water, or into flafks full of dif-ferent liquids that are to be impregnated with the acid.

13. The carbonic acid unites in excefs with moft of the carbonates, or rather, it renders them foluble in water, though they may not be foluble alone. It appears, that it is thus that nature effects the diffolution of earthy carbon-ates in water, and caufes them to cryftallize, as will be feen in the hiftory of their fpecies.

14. The carbonates decompofe many falts which the mere bafes could not decompofe, by means of the double attraction exerted from the union of the carbonic acid with their bafes.

Since the difcovery of thefe decompofitions, many other difcoveries have been made refpect-ing faline fubftances, their nature and products; and the doctrine of elective attractions has been greatly illuftrated.

15. The ufes of earthy and alkaline carbon-ates are extremely numerous; they frequently afford the chemift the moft valuable means of accurate analyfis and fynthefis. A number of
applications

applications of thefe bodies to the arts have been fuccefsfully made. Moft of them conftitute the moft ufeful medicines we poffefs, which can be prepared, with the moft definite knowledge of their nature and of their virtues.

In a word, the mineralogift, by examining them in collections, and the geologift in his travels, arrive, by the light which they afford to chemiftry, to great and important fpeculations concerning their influence and their formation, as well as the theory of mountains, and the operations of the waters which are perpetually difplacing and changing their beds.

16. In the application of my fyftematic arrangement of falts, founded on the relative attraction of the bafes for the acid which conftitutes the genus, I diftinguifh thirteen diftinct fpecies of carbonates, and I arrange them in the following order :

    1. Carbonate of barites.
    2. Carbonate of ftrontian.
    3. Carbonate of lime.
    4. Carbonate of pot-afh.
    5. Carbonate of foda.
    6. Carbonate of magnefia.
    7. Carbonate of ammonia.
    8. Ammoniaco-magnefian carbonate.
    9. Carbonate of glucine.
    10. Carbonate of alumine.
    11. Carbonate of zircone.
    12. Ammoniaco-zirconian carbonate.
    13. Ammoniaco-glucinian carbonate.

SECTION II.

Concerning the Specific Characters of Earthy and Alkaline Carbonates.

SPECIES I.

Carbonate of Barites.

A. *Synonymy; History.*

1. IT is but twenty-fix years, fince 1776, that we have poffeffed a knowledge of this falt, and, but twenty-two fince it was found native. It is to Scheele and to Bergmann that we are indebted for its difcovery, and to Dr. Withering, an Englifhman, we owe the firft information of its exiftence in nature. Its properties have been fucceffively examined by Kirwan, Pelletier, Hope, and myfelf; little now remains to render our knowledge of this fubftance complete.

2. It has been called aerated ponderous fpar, aerated barofelinite, aerated ponderous earth, mephite of barites, chalk of barites, and Witherite, becaufe Dr. Withering difcovered it.

B. *Physical Properties; Natural History.*

3. THE carbonate of barites, artificially prepared, has the form of a white infipid powder, of the fpecific gravity of 3,763.

4. That

4. That which has been found moſt abun-
dantly at Alſton-Moor, in Cumberland, is in
ſtriated, lamellated, and ſemi-tranſparent maſſes;
its preſumptive primary form is that of the hex-
ahedral priſm. It ſpecific gravity is 4,331.

5. It is alſo found in Schotland, in Sweden,
and in the coal-mines of Lancaſhire. It is fre-
quently mixed with ſulphate of barites, car-
bonate of lime, the oxides of iron, and the
ſulphate of the ſame metal. Though the ſul-
phate of barites is much more frequently found
than the carbonate, it may be preſumed that
this laſt will be moſt frequently found accompa-
nying the former: this inquiry ought to excite
the greateſt zeal amongſt mineralogiſts, ſince,
as we may judge from its properties, this earthy
ſalt will hereafter become of the greateſt uſe in
the arts.

C. Extraction; Preparation; Purification.

6. WHEN we poſſeſs the native carbonate of
barites, nothing is required but to chooſe it
very pure, very lamellated, free from metallic
oxides and other extraneous bodies.

7. There are four principal methods of pre-
paring it artificially, by expoſing a ſolution of
pure barites to the air, where it acquires a pel-
licle of this ſalt by abſorbing the carbonic acid
of the atmoſphere; by paſſing through this ſo-
lution, ſome carbonic acid gas which becomes
fixed, and immediately forms an abundant pre-
cipitate;

cipitate; by decompofing the native fulphate of barites in the dry method, by means of fire with the carbonate of pot-afh or foda, and then wafhing the mixture with water, which carries off the fulphate of alkali in the ftate of folution, and leaves the carbonate of barites infoluble; and laftly, by precipitating the diffolved nitrate or muriate of barites, by folutions of the carbonate of pot-afh, of foda, or of ammonia. The two firft and the fourth proceffes afford this falt very pure when the precipitates are well wafhed. The third affords only a mixture of carbonate and fulphate of barites, this laft not being completely decompofed.

D. *Action of Caloric.*

8. NEITHER the artificial, nor the natural carbonate of barites, lofe any of their carbonic acid by the action of fire. The firft contains much more water than the fecond, and this liquid, not being ftrongly adherent to that pulverulent falt, it lofes 0,28 of its weight, and part of its acid efcapes with it by the calcination; whilft the fecond lofes nothing. Dr. Withering firft obferved, that this falt is fufed by a ftrong heat, rather than permits the carbonic acid which it contains, to efcape. It only becomes of an opaque white, like porcelain bifcuit; and alfo affumes a bluifh green colour internally.

E. *Action*

E. Action of the Air.

9. IT is totally or completely unchangeable by the air.

F. Action of Water.

10. COLD water fcarcely at all affects the carbonate of barites. I have neverthelefs found that when left, during a long time in contact with that of Alfton-Moor in very fine powder, it diffolved $\frac{1}{4304}$; and that water boiled for a long time with this native falt carried off from it $\frac{1}{2304}$.

G. Decompofition; Proportion.

11. DR. HOPE has found, that by treating the carbonate of barites in a crucible of black lead, it loft its carbonic acid, whilft in an earthen crucible it permitted nothing to efcape. Pelletier, who has examined and confirmed this fingular experiment, the theory of which is not known to us, has repeated it in the moft accurate manner. He made a pafte of one hundred parts of this falt, and ten parts of charcoal, which he heated in the middle of charcoal powder, and by that fimple procefs he obtained barites pure and foluble; this then is a means of extracting that cauftic alkali very

pure,

pure, very cryftallizable; in a word, poffeffing all the properties afcribed to that fubftance.

12. Though all the acids decompofe the carbonate of barites, each of them produce that effect with certain particular phenomena. The fulphuric acid, concentrated or diluted with two or three parts of water, does not difengage the carbonic acid without effervefcence, unlefs affifted by an elevated temperature. The concentrated nitric acid does not act on it; it diffolves it completely in the cold, and with a lively effervefcence when it is diluted with water, and forms nitrate of barites which remains diffolved in the fluid; fo that there is no folid refidue, when the carbonate of barites is very pure, as I have feen that of Alfton-Moor.

13. This falt, in fmall pieces, as in the two cafes before-mentioned, is not affected by the concentrated muriatic acid; when that acid is diluted, it attacks the carbonate of barites with a kind of decrepitation, and difengages from it carbonic acid gas in large intermitting globules when the acid is very ftrong, and a continual difcharge of fmall globules, till it is completely diffolved when the acid is fo very weak as to weigh no more than between $\frac{1}{25}$ or $\frac{1}{30}$ more than water. The concentrated muriatic acid, which in the cold does not act at all on the carbonate of barites, diffolves it with a ftrong effervefcence when affifted by heat; but, in that cafe, the falt forms itfelf in a mafs. When concentrated and

and fuming muriatic acid is poured into a mixture of carbonate of barites, and of that weak acid which eafily decompofes it, it fuddenly ftops the effervefcence and the diffolution ; but by adding fome water, the action again commences. Solid muriate of barites, thrown into the mixture while effervefcing, alfo ftops it. We may perceive in thefe facts the influence of water, and of its caloric which feparates the particles of the acid and thofe of the carbonate of barites, and favours its folution by its own decompofition. I explained the fubject of the complicated attractions which take place in thefe mixtures, in the Memoir which I publifhed in 1790, concerning the analyfis of the native carbonate of barites of Alfton-Moor. (See Annales de Chimie, tom. iv. pag. 62, and Dictionnaire de Chimie de l'Encycloped. Method. tom. iii. p. 9.)

14. The phofphoric and fluoric acids alfo act on the carbonate of barites, and drive off the carbonic acid by uniting to its bafe, but lefs eafily than the nitric and weak muriatic acids.

15. Liquid carbonic acid, or acidulated water, diffolves $\frac{1}{830}$ of this falt in powder, more than double, as it appears, of that which boiling water diffolves. This folution is decompofed in the air, and by the addition of any of the foluble alkaline and earthy fubftances, which are quickly diffolved and feize the carbonic acid, at the fame time precipitating the barites. It is probable that it is by this acid that nature

diffolves

diffolves and cryftallizes this falt in the bowels of the earth.

16. The carbonate of barites does not act on the falts; but when it is ftrongly heated even with thofe compounds of which the principles are moft adherent, previoufly mixing fome char-coal with it, which poffeffes, as has been already obferved, the property of difengaging its car-bonic acid, the barites is fet at liberty, and at-tracts the acids and difengages their bafe. By this procefs we may decompofe the fulphates and muriates of pot-afh, foda, &c.

17. Chemifts who have analyzed the carbon-ate of barites, whether artificial or natural, and who have endeavoured to determine the pro-portion of its principles, do not perfectly agree in the refult of their analyfis. Mr. Kirwan fays, that a hundred parts of this artificial falt con-tain,

Barites	65
Carbonic acid	27
Water	28

According to him, one hundred parts of the native carbonate of barites are compofed of

Barites	78
Carbonic acid	20
Sulphate of barites	2

In my examination of this falt from Alfton-Moor, chofen in a very pure ftate, I could not find the fulphate of barites. It prefented to me the following proportions,

Barites

Barites   90
Carbonic acid   10

I may, neverthelefs, obferve, that the pro-
portion of barites appeared to be a little too
great, and that in its weight it is neceffary to
include that of the water which I do not know,
but which I admit, though M. Kirwan denies its
exiftence in this falt.   Pelletier found in 100
parts of this native falt,

Barites   62
Carbonic acid   22
Water   16

H. *Ufes.*

18. THE carbonate of barites is only ufed in
the laboratories of chemiftry, for experiments
of demonftration.   When it fhall be found more
abundantly in nature, it will become of the
greateft ufe.   It will not only be ufeful in che-
miftry to prepare all the baritic falts, but it will
render important fervices to the arts in the
formation of many faline fubftances, and in ex-
tracting their bafes.   Some phyficians have
propofed the ufe of this falt as a medicine :
they ought to be aware that it poifons animals,
and that its medical adminiftration confequent-
ly demands the moft fevere and active circum-
fpection.

SPECIES II.

Carbonate of Strontian.

A. Synonymy; History.

1. CRAWFORD firft fufpected that the fof-
fil found at Strontian in Scotland, and regarded
as a carbonate of barites, contained a particular
earth. Dr. Hope proved this in November
1793, and named it ftrontite. M. Klaproth has
confirmed this refult, and difcovered the car-
bonate of ftrontian to be a peculiar falt, with-
out knowing the earlier labours of Mr. Hope.
Schemeiffer, of Hamburg, announced it in his
work on mineralogy. Blumenbach and Sulzer
have called it ftrontianite. It has been con-
founded for fome years with the native car-
bonate of barites, or Witherite. Pelletier, Citi-
zen Vauquelin, and I, have examined it at Paris,
and we are convinced that, notwithftanding
certain analogies with the native carbonate of
barites, this falt differs from it in many pro-
perties already defcribed by Meffrs. Crawford,
Hope, and Klaproth, and which I fhall proceed
to enumerate.

B. Phyfical Properties; Natural Hiftory.

2. THE carbonate of ftrontian is in needles,
or fine ftriated prifms, which appear to be hex-

C 2   ahedral,

ahedral, of a greenifh-white colour.   It weighs
from 36,583 to 36,750.   According to Pelle-
tier, is has no tafle.

3. It was firft found at Strontian in Argyl-
fhire, or the county of Argyl, fituated towards
the weftern part of the north of Scotland.   It
there accompanies a vein of lead; Citizen
Guyot has found it at Lead hills in Scotland,
and took it for a carbonate of barites.   Citizen
Guyton affirms, that it accompanies certain
fpecies of the fulphate of barites.   It is very
probable, likewife, that it will be found abun-
dantly in France, fince the fulphate of ftron-
tian has been found there, and it may probably
exift where this laft is.

C. *Preparation; Purification.*

4. It may be made artificially, by faturating
a folution of ftrontian with carbonic acid, or by
precipitating the foluble falt of that bafe by
the alkaline carbonates.

5. We have known this falt for too fhort a
time to be fkilled in the method of purifying
it from the different fubftances which may
accompany it in nature; but, to have it very
pure we may prefer the artificial mode of pre-
paring it.

D. *Concerning*

D. *Concerning the Action of Caloric.*

6. When the carbonate of strontian is calcined in a crucible without being heated so much as to cause it to melt, it permits five or six parts in the hundred of carbonic acid, to fly off, and afterwards the pure strontian may be separated by hot water, and crystallized by cooling. This salt is, therefore, more easily decomposed than the carbonate of barites. When it is placed on a strong fire, it attacks the crucible and fuses it into a glass, resembling in colour the chrysolite, or the pyramidal phosphate of lime.

E. *Action of Air.*

7. It is entirely unalterable by the air.

F. *Action of Water.*

8. Water has no more action on it than on the carbonate of barites.

G. *Decomposition; Proportion.*

9. The charcoal with which it is heated, after reducing the mixture into the form of a paste according to Pelletier's process, favours the disengagement of the carbonic acid in the state of gas; in this manner it loses 0,28 of its

weight,

weight, and the ftrontian is found pure, and may be diffolved in boiling water, from which, on cooling, it falls down in cryftals. If the carbonate be powdered, and thrown on charcoal well kindled, or on the flame of a burning candle, it exhibits a red fcintillation. The fame phenomenon is obferved with the blow-pipe, which fufes this falt into an opaque vitreous globule, that falls to powder in the open air.

10. The acids decompofe it, and difengage from it the carbonic acid with effervefcence. An hundred parts of this falt, being diffolved in diluted nitric acid, loft eighty by the effervefcence that enfued. The muriatic acid acts on it, as on the carbonate of barites ; and the muriate of ftrontian thus produced is diftinguifhed, as is well known, from that of barites, chiefly by its property of giving a purple-red colour to flame, its figure, &c. When it is treated with fulphuric acid, though diftilled water diffolves very little of the fulphate of ftrontian formed, yet it is rendered very perceptible by the precipitate that muriate of barites occafions.

11. None of the bafes act on carbonate of ftrontian, barites excepted ; which, if heated with this carbonate, decompofes it, and leaves its earth uncombined. It has not been obferved, that the falts have any greater degree of action with refpect to this compound.

12. If thefe properties, the differences of which in thefe firft two carbonates appear but

feebly

feebly marked, and prevented chemifts for feveral years from diftinguifhing them from each other, fhould leave any doubt with regard to their being really diftinct fubftances, let the reader but confider the inferior fpecific gravity of the carbonate of ftrontian, the lofs of part of its acid by fire, the red colour it imparts to flame, and its decompofition by cauftic barites, and his doubt will be quickly removed. But he will prefently fee further proofs of the difference of the two carbonates, in the proportions of their principles, and in their action on the animal economy.

13. According to Pelletier's analyfis, an hundred parts of carbonate of ftrontian are compofed of

Strontian	62
Carbonic acid	30
Water –	8

H. *Ufes.*

14. HITHERTO no ufe has been made of the carbonate of ftrontian : it muft be obferved, however, that Pelletier, in his ufeful experiments on this falt, found it not to be injurious and poifonous to animals, as the carbonate of barites is; which fhould induce phyficians to inquire into the properties of the foluble falts that have ftrontian for their bafe, and compare them with the properties of the faline compounds formed with barites.

SPECIES

SPECIES III.

Carbonate of Lime.

A. *Synonymy; History.*

1. THERE are few faline fubftances, of which the hiftory is fo interefting as that of the carbonate of lime. Exifting in nature in vaft quantity; contributing to the formation of mountains, of which it frequently conftitutes the greater part; inceffantly depofiting itfelf at the bottom of the fea, where for a time it ferves as the fupport, or covering, or fkeleton of innumerable myriads of animals; exhibiting itfelf in a thoufand fubterranean cavities, or clefts, in the brilliant and varied form of tranfparent and regular cryftals; here accumulating in the earth in immenfe ftrata of ftone, there pendant in ftalactites from the fummits of caverns, and further on congealed, or incrufted upon different bodies; in one place compofing the foil of extenfive plains, and receiving the feeds of future harvefts; in others, not a little numerous, diffolved in the waters, and flowing as a liquid with them; raifed by the labours of man to the furface of the earth, and ferving to form the edifices he erects on it, or burned in kilns to that lime, which is neceffary to cement them; in a word, introduced into numerous manufactories for various ufes; the carbonate of lime is

at

at once interefting to the geologift, the mineralogift, the chemift, the philofopher, the naturalift, the manufacturer, the artift, and the mechanic. Accordingly it has been the object of repeated labours and refearch, fince the brilliant period when Black began to render it accurately known, and, in fome degree, to remove it from the clafs of ftones, or earths into that of falts. The fucceffive experiments of Bergmann, Prieftley, Rouelle, Lavoifier, and feveral others, have developed all its chemical properties; while the mineralogical ftudies of Hill, Romé de Lifle, Kirwan, and Citizen Haüy have fcrutinized its different native varieties, its forms fo numerous and diverfified, and the laws that have prefided over the ftructure of thefe feveral forms.

2. As the carbonate of lime has been an object of very extenfive refearch at once to the mineralogift, and to the chemift, it would be found denominated by a multitude of fynonymes, if we reckon among its names thofe given to the various foffils it exhibits. Thus it is *the calcareous matter* in general, *calcareous earth, chalk, lime-ftone, free-ftone, tufa, cron, falun, pure marble, calcareous fpar, incruftations, guhrs, ftalactites, alabafters, Spanifh white*, according to the forms it affects, the appearances it exhibits, the places it occupies, the refemblances it difplays, or the ufes for which it is defigned. The chemifts, on their part, in proportion as they have become better

acquainted

acquainted with it, have fucceffively defignated
it by the appellations of *mild lime, effervefcent
lime, aerated lime, mephite of lime, calcareous
chalk*, and, finally, of carbonate of lime, or
calcareous carbonate, the laft name given in
the methodical nomenclature, and generally
adopted in all the languages, and all the works
of modern chemiftry.

B. *Phyfical Properties; Natural Hiftory.*

3. THE carbonate of lime is deftitute of fla-
vour, which occafioned it long to be confidered
in its folid ftate as a ftone. It cryftallizes in
tranfparent rhombs, and undergoes very nume-
rous varieties of figure. It then exhibits a
double refraction. It weighs 2,700.

4. As it is very abundant and various in
nature, lithologifts have formed of it one entire
clafs of earths or ftones, under the name of
calcareous. They have divided them into an
order, genera, fpecies, and varieties, of which
they have defcribed very numerous feries; and
they might be ftill farther enlarged, without
hope of ever enumerating, or bringing together
all that occur in nature. This natural hiftory
of calcareous matter, one of the foundations of
our globe, and one of the moft abundant of the
materials that compofe it, may be reduced, how-
ever, to a few general and fimple outlines.

5. We may form of it fix principal genera,
having refpect to the principal differences, which
this

this falt affects in its natural ftate. The firft comprifes the primitive carbonate of lime; that which is found in the primitive mountains or thofe primarily formed, though we are unable there to detect its ancient origin. It is in horizontal or vertical ftrata, filling the clefts of granite or of fchiftus; it is often fufficiently pure, fometimes mixed with filex or alumine.

To the fecond genus belong the teftaceous, madreporous, and lythophytic depofitions, which are fo abundant in the more recent mountains, form the foil of fo many plains, and extend from thofe foffil fhells, the fpecies of which are eafily diftinguifhed, to the earths refulting from their pulverization, which exhibit only a few fragments ftill capable of being afcertained to have belonged to marine animals, of which they are the accumulated fpoils, and, in fome meafure, the fepulchral monuments. In this genus are to be claffed all the madrepore and foffil fhells which naturalifts defignate by the addition of the word *lithe* to their original name; the faluns, crons, fhelly earths, lumachelloes, &c.

The third genus will include the calcareous earths and ftones properly fo called; that is to fay, pulverized carbonate of lime, almoft entirely deftitute of perceptible organic forms, and conftituting the chalks, ftone-marrow, tufa, and coarfe and fine-grained calcareous ftones.

In

In the fourth genus will be arranged the marbles, of greater hardnefs and finer texture than the calcareous ftones, and the varieties of which are immenfe with regard to the different matters mingled with them, and the differences of the tints, fpots, and colours, which thefe matters occafion.

To the fifth genus will be referred the calcareous concretions, comprifing the incruftations, ofteocollæ, pretended petrifactions, ftalactites, and alabafters.

In fine, to the fixth and laft genus will appertain the *calcareous fpar* of naturalifts, or the pure native cryftallized carbonate of lime.

6. The laft-mentioned lithologic genus is the true falt, the properties of which fhould be examined with the greateft care. It is that in which chemifts may confider the carbonate of lime as very pure, and which they ought to felect for their experiments. No earthy falt appears fo abundant throughout the globe; none exhibits fo many varieties: befide thofe of colour, purity, tranfparency, femi-tranfparency, or opacity, various mixtures, the mode in which it exifts in the earth, or its fituation; Hill has defcribed a number of modified forms of it; and, in fact, the algebraic inveftigations of the able cryftallographer Haüy have given him as their refult a number of more than eight millions of figures. Every day new cryftals of it are difcovered; already we know forty-two varieties of it with regard to form; and though

it

it is probable, that the circumſtances neceſſary to produce the immenſe varieties, which the calculation of decrements ſhows to be poſſible, will not occur in nature, there can be no doubt that many yet remain to be diſcovered.

7. Impoſſible, and even uſeleſs, as it would be in a ſyſtematic work on chemiſtry, to give a detailed account of the varieties already found in the forms of the native cryſtallized carbonate of lime, I ſhall confine myſelf here to a deſcription of its primitive form, and of twelve of its principal varieties; ſelecting, after Citizen Haüy himſelf, the moſt remarkable, or thoſe which it is of the moſt importance to diſtinguiſh.

Primitive form : an obtuſe rhomboid, the plane angles of which are about $101\frac{1}{2}$ degrees, $78\frac{1}{2}$ degrees ; integral mole-cule the ſame.

Varieties.

A. *Primitive calcareous Carbonate.* This cryſtal has a double refraction : it depends on the circumſtance, that the images of objects appear double when they are ſeen through two parallel faces of this rhomboidal ſalt, and through two faces inclined to each other in other tranſparent minerals having this property.

It has been diſcovered, that all double refracting cryſtals have one direction in which objects

objects appear fingle. In general this effect takes place when one of the faces, through which the object is viewed, is perpendicular or parallel to the axis, according to the difference of the fpecies.

B. *Equiaxal calcareous Carbonate*, vulgarly lenticular : a very obtufe rhomboid, the axis of which is equal to that of the nucleus.

C. *Inverfe calcareous Carbonate ;* the muriatic of De Lifle : an acute rhomboid, in which the plane angles are equal to the refpective inclinations of the faces of the nucleus, and reciprocally. From this inverfion the name of the variety is taken.

D. *Contrafting calcareous Carbonate :* a very acute rhomboid, in which the plane angles are equal to the refpective inclinations of the faces of the very obtufe or equiaxal rhomboid, and reciprocally ; which forms a fort of contraft.

E. *Metaftatic calcareous Carbonate*, vulgarly *hog's tooth :* a dodecahedron with fcalene triangles, in which the great angle of each triangle is equal to the obtufe angle of the nucleus ; and the leaft inclination of the faces equal to the greateft of the faces of the nucleus, whence refults a fort of *metaftafis*, or tranflation of the angles of the nucleus on the fecondary cryftal.

F. *Cuboid calcareous Carbonate ·* a rhomboid flightly acute, differing little from a cube ; difcovered by Citizen Dodun, near Caftelnaudari.

G. *Prifmatic*

G. *Prifmatic calcareous Carbonate :* a regular hexahedral prifm.

H. *Amphipentagonal calcareous Carbonate :* when its prifm is very fhort is called *nail-headed :* a prifm with fix pentagonal fides, terminated at each end by three pentagons different from the former.

I. *Alternate calcareous Carbonate :* a prifm with fix elongated hexagonal fides, terminated at each end by fix quadrilateral faces uniting in a pyramid. The acute angles of the lateral hexagons point alternately upward and downward. Sometimes the fides are reduced to the quadrilateral figure.

K. *Emergent calcareous Carbonate :* the metaftatic, with each of its fummits intercepted by three rhombs parallel to the primitive faces, fo that the nucleus feems to emerge from the fecondary cryftal.

L. *Analogical calcareous Carbonate :* the alternate, with each of its fummits intercepted by three trapezoids belonging to the equiaxal. The name analogical is taken from the different analogies which this variety exhibits, compared with others of the fame fpecies, or of a different fpecies.

M. *Afforted calcareous Carbonate :* the alternate, with each of its fummits intercepted by three rhombs parallel to thofe of the nucleus. The name *Afforted* is taken from this circumftance, that the laws of decrement are perceptible from the fimple pofition of the facets re-

fulting

fulting from them with refpect to the extreme rhombs which belong to the nucleus.

C. *Preparation.*

8. It is obvious that a falt which Nature offers fo frequently and fo abundantly in almoft all places or points of the globe, and which can fo eafily be procured in a ftate of purity, requires neither preparation nor purification. It may be prepared artificially, however, by combining the carbonic acid with lime. In the hiftory of the latter it has been feen that this acid, in a gafeous ftate, is rapidly abforbed by the folution of lime, and that it forms therein a precipitate of calcareous carbonate : to thefe particulars it is to be added, that, to compofe calcareous carbonate, which fhall be at the fame time very pure, it is neceffary to employ a juft and well-proportioned dofe of the carbonic acid : if too little be ufed, the firft precipitate of calcareous carbonate formed, re-diffolves in the lime-water, and feems to form a carbonate with excefs of lime : if too much be employed, the calcareous carbonate at firft precipitated re-diffolves, and difappears in the excefs of carbonic acid : it is true, in this cafe, it may be made to re-appear by adding frefh lime-water, or by difengaging the excefs of acid by means of fire.

D. *Action of Caloric.*

9. THE carbonate of lime, expofed to a fudden heat, decrepitates, lofes its water of cryftallization, becomes white, opaque, and much lefs friable than fulphate of lime treated in the fame manner. If it be heated more, the carbonic acid is expelled, flying off in the ftate of gas. By making this experiment in a clofe veffel, and particularly in a caft-iron retort, or a gun-barrel, to which is fitted a tube paffing under jars filled with water, we may collect the carbonic acid gas, making nearly 0,32 of the weight of the falt. At the fame time a little hidrogen gas is frequently obtained, in confequence of the reciprocal action between the water and the fides of the iron veffel. If the operation be performed in porcelain tubes or retorts, no hidrogen gas will be produced. Retorts of ftone or earthen ware let part of the carbonic acid gas efcape through them, and deceive us refpecting the refults, as Rochefoucauld and Prieftley found upon trial. What remains in the apparatus employed is pure quick-lime.

10. In the art of the lime-burner, lime-ftone, or carbonate of lime in ftony maffes, marble, calcareous fpar, oyfter-fhells, &c. are made to undergo a fimilar change. This art confifts intirely in the decompofition of the falt by means of fire. A kiln is conftructed with pieces of

the lime-ftone itfelf; between them are left in-
tervals or vacuities, to permit the flame to pafs
through and ftrike upon them on all fides; a fire
is made with wood or coal to heat them; the
water, and gafeous and carbonic acid are diffi-
pated in the atmofphere; the operation is con-
tinued till the whole of the falt is intirely de-
compofed, deprived of water and acid, and re-
duced to its pure bafe; and thus quick-lime is
obtained.

E. *Action of Air.*

11. THE carbonate of lime is not altered by
the contact of air; it neither lofes nor abforbs
moifture.

F. *Action of Water.*

12. WATER does not diffolve the carbonate
of lime, in whatever quantity this fluid be em-
ployed, or to whatever temperature it be raifed.

G. *Decompofition; Proportion.*

13. THE carbonate of lime experiences no
alteration from feveral combuftible bodies:
charcoal does not promote the evolution of its
acid, as it does with refpect to the carbonates of
barites and ftrontian; or, at leaft, this property
has not been afcertained.

14. Phofphorus

14. Phofphorus decompofes it with the affift- ance of a temperature above that of boiling water; phofphoric acid being formed, which unites with the lime, and oxide of carbon is difengaged, which fuddenly blackens the mixture. This remarkable decompofition is owing to a difpofing and double elective attraction, which has been explained at full in the firft fection of this article. The reader will recollect, that carbon does not decompofe the phofphate of lime.

15. When calcareous carbonate is heated ftrongly with fulphur, fulphuret of lime is formed, and gafeous carbonic acid is evolved at the moment when the fulphuret is formed, and melts. In this cafe the carbonic acid gas carries off with it a little fulphur in the ftate of vapour, which gives it a fetid fmell.

16. This falt does not attack metallic oxides, and no combination will take place between thefe fubftances.

17. All the acids decompofe calcareous carbonate, and difengage from it the carbonic acid with effervefcence, in proportion to the caloric feparated from the lime and from the acid at the fame time; fo that here we find a double attraction takes place, namely, that of the acid for the lime, and that of caloric for the carbonic acid. Accordingly this effervefcence is accompanied with cold, or with no increafe of temperature; while, if the fame acids be com-

bined

bined with lime, much heat is produced, or a confiderable portion of caloric fet at liberty.

18. The carbonic acid eafily diffolves carbonate of lime, and it is in this manner it is diffolved in all waters that contain it naturally. When this acid is difengaged from the water by the contact of air, and more efpecially by the action of caloric, the carbonate of lime fubfides in the form of powder. This is what takes place in the waters that form incruftations on bodies wetted by them in the channels through which they pafs, as thofe of Arcueil near Paris, of Saint Allyre at Clermont-Ferrand, of the baths of San Filippo in Italy, and a number of others. If we add lime-water to this folution of calcareous carbonate by carbonic acid, this falt will be precipitated from the water. The fame phenomenon occurs on putting into the folution pot-afh, foda, or ammonia, which feizes the carbonic acid, and confequently obliges the carbonate of lime to quit the water, by reftoring its infolubility.

19. Barites and ftrontian decompofe calcareous carbonate, and deprive it of its acid. The alkalis do not effect a fimilar decompofition. Silex and alumine are equally incapable of acting upon this falt. With a ftrong fire they enter into fufion with its bafe, from which the carbonic acid flies off. Lime itfelf appears to have a fort of attraction for this falt, fince it effects its folution in water, as has been faid above.

20. Carbonate

20. Carbonate of lime has no fenfible action on moft of the falts : thofe alone, of which ammonia is the bafe, are decompofed by it, with the affiftance of a high temperature. The acid of thefe ammoniacal falts, in this cafe, attacks the lime, while the carbonic acid unites with the ammonia. The carbonate of ammonia fublimes in proportion as it is formed, and in its flow fublimation affumes an irregular figure. It is thus that carbonate of ammonia is prepared from ammoniacal muriate and calcareous carbonate, as will be feen hereafter.

21. According to Bergmann, 100 parts of very pure calcareous carbonate are formed of

Lime	55
Carbonic acid	34
Water	11

H. *Ufes.*

22. THE ufes of carbonate of lime are very multifarious. Its hard maffes, of a fine grain, and fufceptible of a polifh, are employed by the fculptor : its maffes lefs fine than the preceding, are ufed for building, under the name freeftone. Its foft, or common ftones, are made into lime ; and there is not one variety of this falt which is not deftined to anfwer fome purpofe of induftry or economy. Chemifts employ it in a great number of operations.

SPECIES

Species IV.

Carbonate of Pot-Aſh.

A. Synonymy; Hiſtory.

1. CARBONATE of pot-aſh was long uſed in chemiſtry and in the arts, without its being properly known and diſtinguiſhed from the vegetable alkali, as it was called. The character of effervefcing with acids, afcribed to it, evidently proves this. Afterwards Black, Jacquin, Chaulnes, Lavoiſier, Berthollet, and Pelletier, fucceſſively turned their attention to the properties of this falt, and each added fome additional information to its hiſtory. As early as 1666 Bohnius announced its property of being cryſtallizable; and in 1764, Montet, a chemiſt of Montpellier, had obtained cryſtals of it before its nature was known.

2. Since its characters and compoſition have begun to be ſtudied, it has been called *mild vegetable alkali, effervefcent fixed alkali, aerated fixed alkali, alkaline chalk, mephitic tartar, mephite of pot-aſh,* fubfequently to the names of *fixed falt of nitre, falt of tartar, fixed nitre, white flux, fixed alkali,* under which it was known before the difcovery of the acid which conſtitutes it a falt.

<div align="right">B. <i>Phyſical</i></div>

B. *Phyſical Properties.*

3. CARBONATE of pot-aſh cryſtallizes in ſquare priſms terminated by quadrangular pyramids. It has a mild urinous flavour: it turns ſyrup of violets green.

4. It has not yet been found in the foſſil kingdom. It is met with in the juices of vegetables; and it is extracted chiefly from their aſhes, particularly in great abundance from thoſe of the tartareous acidule. It is much more rare in animal ſubſtances. Hence we ſee the reaſon why this ſalt, when it was ſuppoſed to be pure fixed alkali, had the name of vegetable alkali given it.

C. *Preparation; Extraction.*

5. WHEN it is extracted from vegetable ſubſtances by incineration and lixiviation, it is never pure. Beſides its not being ſaturated with carbonic acid, it almoſt always contains ſilex, and different ſalts. It is purified by paſſing into its ſolution carbonic acid gas, which is abſorbed.

6. This ſalt is often prepared ſpeedily, and as was formerly ſaid, extemporaneouſly, by detonating together nitre and tartar. The carbonic acid, which is formed in this rapid combuſtion, unites to the pot-aſh that remains, but it never

faturates

faturates it in the procefs, and more is obliged
to be added afterwards when it is diffolved.

7. The procefs of Chaulnes alfo is well adapted
to afford carbonate of pot-afh. It confifts in
expofing a pure folution of pot-afh to the car-
bonic acid gas, evolved from fermenting wort,
and ftirring the liquor well by means of an agi-
tator. Thus the acid is quickly abforbed; the
carbonate of pot-afh formed cryftallizes in the
middle of the liquor; it is dried in the air on
blotting paper, and muft be kept in bottles
clofely ftopped.

8. If we have not a brewer's vat at com-
mand, we may pafs carbonic acid gas, difen-
gaged from carbonate of lime by means of ful-
phuric acid, into a folution of pot-afh, in tall,
narrow bottles. The carbonate of pot-afh cryf-
tallizes on the furface of the liquor, and round
the tubes, which we muft take care to choofe of
a large fize, that they may not be ftopped up by
the falt. It was thus Pelletier obtained cryftals
of carbonate of pot-afh in tetrahedral rhom-
boidal prifms terminated by dihedral fummits.

9. Citizen Berthollet has given another pro-
cefs for preparing carbonate of pot-afh. This
confifts in diftilling, with a folution of the al-
kali not faturated, folid carbonate of ammo-
nia, from which the pot-afh takes the carbonic
acid; fo that the carbonate of pot-afh cryftal-
lizes in the retort, while the ammonia is difen-
gaged in the ftate of gas, or of cauftic liquor.

D. *Action*

D. *Action of Caloric.*

10. THE carbonate of pot-afh melts with a gentle heat, and afterwards lofes its water of cryftallization, which is from 0,15 to 0,17. A portion of its carbonic acid is alfo difengaged; but all its acid cannot be expelled by this procefs, the laft portion adhering to it very forcibly, fo that the action of caloric cannot be employed to make an accurate analyfis of this falt.

E. *Action of the Air.*

11. WHEN very pure and well cryftallized carbonate of pot-afh is expofed in contact with dry air, it foon becomes covered with a light white duft, which announces it to be efflorefcent. Yet before chemifts were acquainted with this falt in its faturated ftate, they imagined it was its character to attract the water of the atmofphere, and denoted it by the name of Deliquefcent Alkali. When it grows moift in the air, it is becaufe it is not faturated with carbonic acid, and contains a portion of unmixed or cauftic pot-afh, which is extremely fufceptible of attracting the atmofpheric moifture.

F. *Action of Water.*

12. CARBONATE of pot-afh requires nearly four times its weight of water at the temperature

ture of 0, to diffolve it; and, in its diffolution, cold is produced. When at 75°, or 80° of Reaumur's thermometer, it diffolves five-fixths of its weight; yet the falt does not cryftallize by cooling, but only by a flow and gentle evaporation. Pelletier obferved, that, on diffolving well-faturated carbonate of pot-afh in boiling water, bubbles of carbonic acid gas were difengaged; which convinced him, that this falt loft a portion of its acid, as the effect of this folution by means of heat.

G. *Decompofition; Proportions of its Principles.*

13. Combustible fubftances have no very marked action on carbonate of pot-afh. It is not known whether carbon has the property of promoting the difengagement of its acid by heat, or not. On heating this falt with fulphur, at a high temperature, the carbonic acid efcapes in the ftate of gas, and a fulphuret is formed at the very moment of the effervefcence produced by the difengagement of this acid.

14. Some metallic fubftances, heated with carbonate of pot-afh, experience an oxidation; but this is owing to the water contained in the falt, which is decompofed by the difpofing attraction, which the pot-afh, and even the carbonic acid, exert on the oxide of the metal. But this action is feeble.

15. All the acids hitherto known have the property of decompofing the carbonate of pot-afh,

of

of difengaging from it carbonic acid gas with effervefcence, and of forming with its bafe, or the pot-afh, thofe falts which they ordinarily conftitute. By this decompofition, and the dif-engagement of its volatile acid, the falt lofes more than a third of its weight.

16. Barites, ftrontian, and lime, decompofe car-bonate of pot-afh, taking from it the acid, and leaving the pot-afh difengaged, becaufe they have a ftronger attraction for the carbonic acid than this fixed alkali has. In making the experi-ment in the humid way, or mixing thefe fub-ftances in a ftate of folution, precipitates of infoluble carbonates are formed, and the pot-afh remains in the fupernatant water. Lime, as the leaft expenfive and moft common, is em-ployed moft frequently in this important opera-tion, by which pure pot-afh is obtained. The carbonate of pot-afh is mixed with half its weight of very ftrong quick-lime, on which it is fpread: water is thrown on to flack the lime; it is then diluted, and abforbs the carbonic acid, paffes to the ftate of carbonate of lime, which is infoluble, and the pot-afh remains pure and cauftic in the liquor. This procefs, termed cauftification, is employed in laboratories for procuring pure pot-afh. It manifeftly depends altogether on the attraction that exifts between the lime and carbonic acid being more power-ful than that between the fame acid and pot-afh. Under the article pot-afh I have already fhown how this operation is performed, and the pro-

perties

perties acquired by the pot-afh thus puri-
fied.

17. Silex and alumine do not act in cold on
the carbonate of pot-afh. If they be heated
ftrongly together, the carbonic acid flies off in
gas, and with a brifk effervefcence, at the mo-
ment when the pot-afh combines with the earths
in the ftate of glafs. Thus it appears, that
thefe vitrefcible earths at a high temperature
favour the difengagement of carbonic acid;
and that the double attraction of the alkali for
the earth, and of caloric for the acid, effects a
complete decompofition of the carbonate of
pot-afh; which does not take place, as is well
known, from the attraction of caloric fingly.
Accordingly, in glafs-houfes, where pot-afh
partly in carbonic acid is ufed, a confider-
able ebullition is perceived in the pots where
the glafs is made; and it is alfo obferved,
that this effervefcence muft ceafe for the vitri-
fication to be complete. It is likewife in con-
fequence of this property, that lithologifts em-
ploy carbonate of pot-afh, to diftinguifh with
the blow-pipe, by means of the effervefcence
and the well-fufed and tranfparent vitreous glo-
bule, filiceous ftones, which alone exhibit thefe
properties.

18. The action of carbonate of pot-afh on
falts is very different from that of fimple pot-
afh. In the firft place, all the calcareous, ftron-
tian, ammoniacal, magnefian, and aluminous
falts, which fimple pot-afh decompofes, and
from

from which it precipitates or feparates their bafes pure, afford, on the addition of the carbonate, more copious precipitates, which are infoluble carbonates. In this cafe double elective attractions occur, but they are *fuper-fluous* for the purpofe of the decompofition, fince this would be effected by the pot-afh alone. They muft be confidered only as double combinations, the refults of which are on the one hand falts, with bafe of pot-afh; and on the other, infoluble carbonates. Thus we obtain the ammoniacal carbonate, which fublimes, when muriate of ammonia and carbonate of pot-afh are treated in the dry way in a retort.

19. But the cafes in which the double elective attraction produced by the carbonate of pot-afh is neceffary, to effect the decompofition of certain falts, are much more important ftill than the preceding. Salts, with barites for their bafe, particularly belong to this clafs. Pot-afh alone does not feparate this bafe, which adheres fo ftrongly to acids : but the attraction of the carbonic acid for barites, added to that of pot-afh for the acid, which holds the barites diffolved, effects the feparation. Accordingly, on pouring a folution of carbonate of pot-afh into a folution of nitrate or muriate of barites, a copious precipitate of carbonate of barites in the form of a white powder enfues, and the fupernatant liquor retains nitrate or muriate of pot-afh. Thus the artificial carbonate of barites is

2   prepared,

prepared. The fame phenomenon takes place in the dry way; and this is particularly employed for decompofing the fulphate of barites, which is not foluble, by dry carbonate of potafh. A great quantity of the latter is requifite in this procefs; it is alfo neceffary to heat the mixture ftrongly; and even then only a portion of the fulphate will be decompofed; and we are obliged to repeat the operation feveral times following. On lixiviating the product heated to the point of fufion, a folution of fulphate of pot-afh will be obtained, and carbonate of barites in powder will remain, frequently mixed with fulphate of barites not de-. compofed.

20. According to Bergmann, the carbonate of pot-afh contains, in a hundred parts,

Pot-afh	48
Carbonic acid	20
Water	32

According to Pelletier, a hundred parts of this falt thoroughly faturated, have the following proportions:

Pot-afh	30
Carbonic acid	43
Water	17

The latter chemift appears to have faturated the pot-afh more completely with carbonic acid.

H. *Ufes.*

H. *Ufes.*

21. THE ufes of carbonate of pot-afh in che-miftry are very numerous. In medicine this falt is confidered as attenuant, and even lithontriptic; but very improperly and erroneoufly. When we wifh to adminifter it, we fhould prefcribe it only in the ftate of very regular cryftals. In the arts it is never employed very pure: it is commonly a mixture of pot-afh, and carbonate of pot-afh, that is ufed in glafshoufes and by dyers. This faline fubftance being pretty fcarce in fome countries, and confequently more or lefs valuable, it may be hufbanded much more than is commonly practifed, by extracting it by evaporation and incineration from lixivia kept after being ufed. In this point a great improvement may be made in manufactories, where this fubftance is inconfiderately wafted.

SPECIES V.

Carbonate of Soda.

A. *Synonymy; Hiftory.*

1. NATURALISTS had long known the carbonate of foda, and it had been long in ufe, before it was accurately diftinguifhed from foda itfelf; for, without appreciating it with preci-

4

fion,

fion, they had at leaft diftinguifhed the very different ftate of this falt, after having extracted it from crude foda by lixiviating this with water, chiefly by its cryftalline form, and by its efflorefcence. This diftinction particularly led to the difference obferved between the falt of foda and the alkali of pot-afh, &c. At the period when Black difcovered the ftate of alkalis rendered mild by *fixed air*, or carbonic acid, this difference was inftantaneoufly feen.

2. From that period to the eftablifhment of the methodical nomenclature, the names of this fubftance, then placed in the clafs at leaft of compound, if not of neutral falts, have changed like thofe of the other carbonates. It has been called *aerated, marine, or mineral alkali, chalk of foda, mephite of foda, natron, falt of foda.*

B. *Phyfical Properties.*

3. CARBONATE of foda is found abundantly in nature. It efflorefces on the furface of the ground in Egypt, where it has been known from time immemorial under the name of *nitrum, natron,* or *natrum;* and hence it has been propofed to retain the laft-mentioned name, even fince our more accurate knowledge of the nature of this falt, which bore it from the moft remote antiquity. In the Delta, where it is fo abundant, it appears to originate from the decompofition

compofition of falt or muriate of foda, diffufed through layers of vegetable and animal mud, and no doubt promoted by the pot-afh which the fpontaneous decompofition of the vegetables furnifhes.

4. Carbonate of foda is obferved efflorefcent in fome dry cellars, or places built underground. It is extracted from the afhes of fome marine plants, particularly from that whence it has received its name. Thefe plants are burned; their afhes are calcined in a ftrong fire, till they begin to vitrify; and what is prepared in this way in the great under the name of foda, is a mixture of different falts, earths, fand, charcoal unburned, and oxide of iron in different ftates, with more or lefs alkali of foda faturated with carbonic acid. This preparation muft neceffarily vary according to the plants employed, the manner in which they are burned, the foil where the incineration is made : it contains more or lefs carbonate of foda; and as this fpecies of alkali demands lefs carbonic acid to faturate it to the degree of a true carbonate than pot-afh requires, the falt is obtained pure and cryftallized directly from crude foda by fimple lixiviation. On this account the carbonate of foda was in fact known long before the carbonate of pot-afh, and called falt of foda.

5. It has not yet been explained how marine plants, and particularly the *falfola of foda* of Linné, afford foda. From the analyfis of Citizen Vauquelin, a portion of alkaline falt ap-

pears to be contained in them already formed ;
but it may be prefumed, that another portion
is feparated from the marine falt with which the
juices of thefe plants are impregnated, by means
of the pot-afh which the combuftion develops.
It is to be obferved, that the algæ and fuci
burned in fome countries, particularly at Cher-
bourg, afford much lefs foda than the falfolas,
or kalis, as they are alfo called.

6. Carbonate of foda exifts likewife diffolved
in fome mineral waters. Thofe of Vichy, and
many others, particularly in the neighbour-
hood of Clermont-Ferrand, contain a quantity
fufficiently great, not only to impart to them
very efficacious medicinal properties, but even
to enable this ufeful faline fubftance to be ex-
tracted from them with advantage for the pur-
pofe of commerce.

7. The carbonate of foda is found alfo in the
animal fluids, and even in the bones, much more
frequently than the carbonate of pot-afh, which
is met with only in certain particular cafes, or
in fome particular fluids.

8. The carbonate of foda cryftallizes in irre-
gular or rhomboidal octahedra, formed by two
quadrangular pyramids truncated very near to
their bafes, which exhibit folid decahedra, hav-
ing two acute and two obtufe folid angles. Fre-
quently it yields only rhomboidal laminæ ap-
plied on one another obliquely. Its favour is
urinous, and a little acrid, without being cauf-
tic, and it turns green fuch blue vegetable co-
lours

lours as are fufceptible of this change: thefe two properties fhow that foda, though faturated with as much carbonic acid as will combine with it, has not its alkaline qualities completely mafked.

C. *Preparation; Purification.*

9. THE natural ftate of faturation of foda by the carbonic acid, and that of carbonate of foda which exifts in the foda of the fhops, allow it to be extracted tolerably pure from this fub- ftance, as has been already faid. For this it is fufficient to lixiviate with a fourth, or, at moft, a third, of pure cold water, foda well chofen, and which has been left for fome time to efflor- efce in dry air, in order to feparate the carbon- ate from the fubftances mixed with it; to filter this liquor, to evaporate it, till it forms a flight pellicle compofed of little cubes, which are muriate of foda; to fkim off this falt with a ladle, or feparate it by means of a hair fieve plunged in the liquor, and taken out from time to time; to continue the action of the fire till no more marine falt is formed; and then to let the liquor cool. The carbonate of foda cryftallizes on its cooling, and thus even affords very regu- lar cryftals.

10. The facility with which very pure car- bonate of foda may be procured, renders it unneceffary ever to prepare it by art: and it would be altogether fuperfluous to take cauftic

foda

foda for this purpofe, and faturate it with car-
bonic acid, fince cauftic foda is procured only
from the carbonate of this bafe extracted im
mediately from foda.

D. *Action of Caloric.*

11. THE carbonate of foda is affected dif-
ferently from that of pot-afh when expofed
to the action of fire. It melts very quickly
by means of its water of cryftallization, which
is in great abundance, after which it dries :
but it is not long before it undergoes the
real igneous fufion, if the heat be continu-
ed. Though it may be deprived of the greater
part of its carbonic acid by a ftrong heat, it
is with very great difficulty the laft portions
of it are expelled. On comparing its fufibility
with that of carbonate of pot-afh, it is obferved
to be a little more eafy, and a little more dif-
tinct ; on which account the former is frequent-
ly preferred to the latter in glafs-houfes.

E. *Action of the Air.*

12. THERE is a very ftriking difference be-
tween the two alkaline carbonates in the manner
in which they are acted upon by the air. It
has been feen that the carbonate of pot-afh is
fcarcely altered by it, barely experiencing a
flight efflorefcence when it is in fmall, badly-
formed cryftals. The carbonate of foda, on
the

the contrary, when beſt cryſtallized, and in the largeſt cryſtals, very ſpeedily loſes its water of cryſtallization in the air, rapidly efflorefces, and falls to powder, even to the laſt cryſtalline particle. This ſalt is indeed one of the moſt efflorefcent known ; and this property depends on the great quantity of its water of cryſtallization, the greater part of which the air takes from it with ſingular energy. Its former regular figure, tranſparency, and ſolidity, will be re-produced by reſtoring the water of which it was deprived by the air.

F. *Action of Water.*

13. THE carbonate of foda is more foluble in water than the carbonate of pot-aſh, ſince it requires only two parts at the temperature of 10°, while the latter requires four. Boiling water diſſolves a little more than its own weight, ſo that it cryſtallizes on cooling, though a much more regular cryſtallization is obtained by ſlow or ſpontaneous evaporation.

G. *Decompoſition; Proportions.*

14. THIS ſalt greatly reſembles carbonate of pot-aſh in the laws and phenomena both of its own decompoſition, and of that which it produces on other ſaline ſubſtances. Carbon has no action upon it with which we are acquainted. With ſulphur it unites at a high temperature,

loſing

lofing its carbonic acid, which is difengaged
with a brifk effervefcence at the moment when
the fulphur is formed. It does not act percep-
tibly on metallic fubftances, except fuch as are
eafily decompofed by water.

15. This, and the carbonate of lime, are
more decompofable by phofphorus than any other
falt of the genus. At the inftant when this
combuftible fubftance, becoming volatile, tra-
verfes the carbonate of foda, previoufly heated,
as is done in the tube which I defcribed in the
hiftory of the carbonic acid, all the white mafs
of falt is found to be blackened. On breaking
the tube when cold, into which the carbonate
of foda was put in powder, a black agglutin-
ated mafs is found, nearly of one fingle piece,
and as folid as foft friable coal; which, being
lixiviated with hot water, leaves a refiduum of
charcoal in very fine powder, and almoft pure,
while the phofphate of foda is diffolved by the
water. The facility of this decompofition has
induced modern chemifts to choofe this faline
fubftance for fhowing the action of heated
phofphorus on carbonates.

16. All the acids, even the boracic acid af-
fifted by heat, decompofe the carbonate of foda,
difengaging the carbonic acid with efferve-
fcence, while they feize on the foda; the caloric
thus feparated diffolves the carbonic acid into
gas, and the decompofition is accompanied with
a decreafe of temperature proportionate to this
abforption of caloric; which proves that the

<div align="right">weaknefs</div>

weaknefs of this acid is owing to its extreme folubility in caloric, and to the fingular tendency it has to affume the gafeous form.

17. Barites, ftrontian, lime, and pot-afh, take the carbonic acid from foda, and leave this alkali feparated and uncombined. The folution of thefe three bafes, more attractable than foda by the carbonic acid, form in the folution of carbonate of foda a precipitate of infoluble carbonate. To obtain pure foda from this falt lime is ufed, and exactly the fame procefs is employed as with the carbonate of pot-afh.

18. Silex and alumine, which do not act cold and in the humid way on the carbonate of foda, combine with its bafe, and convert it into the vitreous ftate by the affiftance of heat. On this occafion, as in the fimilar treatment of the carbonate of pot-afh, the carbonic acid flies off in gas, and with a brifk effervefcence, at the moment when the earth melts with the foda; and the caufe of this phenomenon is the double affinity of the filex or alumine for the foda and of caloric for the carbonic acid. In fact the laft has a tendency to affume the form of gas through the means of the caloric, while the foda itfelf tends to remain in a folid, fixed, and vitreous ftate, uniting with the one or the other of the earths we have mentioned.

19. With the falts carbonate of foda comports itfelf in the fame manner as the carbonate of pot-afh. Salts, with bafe of lime, ammonia, or magnefia, are inftantly decompofed and precipitated

precipitated in earthy carbonates, while the very foluble falts of foda remain in the fupernatant liquor. But here a *fuperfluous* double elective attraction takes place, fince the decompofition would be effected by foda alone, which has a greater affinity for the acids than the earths or bafes mentioned.

20. On the contrary, a true, or *neceſſary* double elective attraction is difplayed, when the baritic falts are treated with carbonate of foda. There is a complete decompofition at the inftant we pour a folution of carbonate of foda into folutions of fuch of thefe falts as are foluble, the nitrate and muriate of barites for inftance; or when we heat in crucibles the infoluble baritic falts, the fulphate, phofphate, or fluate of barites, with three or four times their weight of carbonate of foda. To give the explanation and circumftances of thefe phenomena, would only be to repeat what was faid in the preceding fpecies, except one effential remark which muft not be omitted, that the affinity of the carbonic acid acts an important part in this experiment, fince that of foda for the acids, united to the barites, is weaker than that of pot-afh.

21. According to the analyfis of Bergmann, which I found to be accurate by my own experiments, the refults of which gave me no difference from thofe of the celebrated Swedifh chemift worth notice, a hundred parts of carbonate of foda contain, of

Soda

Soda	20
Carbonic acid	16
Water	64

It is to be obferved, that this carbonate contains more carbonic acid than pot-afh, which depends on its weaker attraction; for it is a general rule in chemiftry, particularly with regard to the falts, that the more weak the component principles are, the more they require reciprocally for their faturation; the more of the bafe if we confider the acids, the more of the acid if we confider the bafes. The truth of this principle may eafily be verified by comparing together the attractions and proportions of the principles that conftitute the falts hitherto examined.

H. *Ufes.*

22. CARBONATE of foda is one of the moft ufeful of the falts to chemifts. It may be prefcribed in medicine as the carbonate of pot-afh. In the arts likewife it is among the fubftances moft frequently employed. It is ufed particularly in glafs-houfes, where it is preferred to the carbonate of pot-afh as a better folvent; and in foap manufactories, where it is decompofed by lime, and forms hard foaps. It enters into the preparation of dyes and lixivia, and of many pharmaceutical compofitions or mixtures. Mineralogifts employ it with the blow-pipe as a folvent, and it conftitutes an effential ingredient in their examinations of foffils.

Species VI.

Carbonate of Magnesia.

A. Synonymy; History.

1. THE carbonate of magnesia, called fuc-
ceffively *mild magnesia, effervescent magnesia,
aerated magnesia, mephite of magnesia, chalk of
magnesia*, could not be faid to have been known
before the period when Black diftinguifhed the
alkaline fubftances, united with fixed air, from
thofe which are deprived of it. It is even
one of the fubftances in which that learned
philofopher, who made this acid the object of
his refearches, firft noticed its prefence. Berg-
mann afterwards examined it with care; and,
laftly, I added feveral notions refpecting the
properties of this earthy falt, which had efcaped
the chemifts that preceded me in this career.
There is no faline fubftance more accurately
determined and ftudied with regard to its cha-
racter than this.

B. *Physical Properties; Natural History.*

2. THE carbonate of magnefia is frequently
in the form of a white powder, light, taftelefs,
and void of acrimony, and fometimes aggluti-
tinated into a fort of cakes fomewhat refem-
bling

bling ftarch. This falt, however, is capable of affuming a regular cryftalline form. I was the firft who obtained and defcribed its cryftals, which are fmall prifms with eight regular rhomboidal fides, truncated obliquely at their extremities, or rather without pyramids: the plane cuts the axis of the prifms obliquely. In this form it is well faturated with carbonic acid, while, in powder, it does not contain the quantity neceffary to prevent its abforbing more; fo that, confequently, in the latter form, it does not poffefs the complete properties of the falt. The cryftallized carbonate of magnefia is of a tolerable confiftence.

3. It has not yet been found in nature, or met with in foffils, though it is probable that it does exift in them, and form fome tranfparent cryftalline fubftance, hitherto, perhaps, confounded with fome variety of what is called calcareous fpar. The fact that feveral varieties of carbonate of lime in the form of chalk, depofitions, incruftations, marble, &c. are fometimes mixed with a certain quantity of pulverulent carbonate of magnefia, which is demonftrated by chemical analyfis, affords particular grounds for this fufpicion.

C. *Preparation.*

4. For want of native carbonate of magnefia, which is not yet known, this falt is prepared artificially by mixing a folution of ful-

4

phate

phate of magnefia with a folution of carbonate of pot-afh, which does not immediately afford a precipitate, but which yields at the expiration of a few hours, and in proportion as the liquor lofes the carbonic acid, which held it in folution, carbonate of magnefia in brilliant and very regular cryftals, or prifms of fix equal fides.

5. It may be equally obtained by diffolving pure magnefia in water impregnated with carbonic acid, and expofing this folution to the air : in proportion as the acid evaporates, the falt is depofited in tranfparent prifms, as in the preceding inftance. Thefe cryftals are feveral millimetres in length, and very eafily recognized by the naked eye.

6. It is not faturated carbonate of magnefia, but merely magnefia united in part with carbonic acid, that is precipitated under the ordinary circumftances in laboratories, particularly for pharmaceutic ufe. The following procefs fucceeds beft for obtaining carbonate of magnefia in the non-faturated and pulverulent ftate. One part of the pot-afh of the fhops is diffolved in two parts of water. This is expofed to the atmofphere for fome months, that it may become faturated with carbonic acid, and purify itfelf by the depofition of the filex it contains. On the other hand an equal weight of fulphate of magnefia is diffolved in four or five times its weight of water, and fifteen parts of water are added to this folution after it has been filtered. This liquor is fet over the fire, and when it

boils,

boils, the folution of pot-afh is poured into it; the precipitate of carbonate of magnefia fub- fides; the carbonic acid, which would have diffolved it if cold, is difengaged with effer- vefcence as it feizes the free caloric; the mix- ture is well ftirred and filtered, and the pre- cipitate is wafhed with boiling water to free it from any extraneous falt; the earthy carbonate is left to drain, and fpread in thin layers on paper, which is carried to the drying ftove; and this fubftance, when dry, is in white fria- ble pieces, or a fine powder, that adheres to the fkin. Such is the preparation of the magnefia ufed in medicine, or of the carbonate of mag- nefia not faturated with acid.

D. *Action of Caloric.*

7. THE cryftallized carbonate of magnefia, when expofed to the fire in a crucible, decrepi- tates flightly, lofes the water and the acid which it contains, and falls to powder. In this way the falt lofes 0,75 of its weight; that which is not faturated, and which is called common magnefia, does not experience an equal lofs. When it is calcined in the great, it is agitated, and feems to boil, by the difengagement of the carbonic acid gas. A fmall portion of this falt is carried off in a kind of vapour, which depo- fits a white powder on cold bodies. In a dark place, and towards the end of the operation, the magnefia fhines with a blueifh phofphoric light.

light. In this calcination the carbonate of magnefia lofes about half its weight. The magnefia remains pure, after having undergone the action of fire.

E. *Action of the Air.*

8. This falt, when cryftallized in regular tranfparent prifms, very fpeedily lofes its tranfparency by expofure to the air. It becomes covered with a white powder, which adheres to the falt, and defends its interior ftrata. It lofes thus about an eighth of its weight. The non-faturated pulverulent carbonate of magnefia experiences no alteration from the air.

F. *Action of Water.*

9. The cryftallized carbonate of magnefia diffolves in forty-eight times its weight of water, at ten degrees. That which is pulverulent and non-faturated requires more than ten times this proportion of water, at the fame temperature, to diffolve it, and firft forms a pafte with a fmall quantity of the liquid. When the folution of the cryftallized falt is evaporated flowly by a gentle fire, fmall needles are obtained ; if it be fuffered to evaporate fpontaneoufly in the air, it will yield the hexahedral prifms mentioned above.

G. *Decompofition;*

G. Decompofition; Proportions.

10. THE carbonate of magnefia is not perceptibly altered by combuftible fubftances. Charcoal does not promote the difengagement of its acid, which is eafily effected by the action of fire alone. Phofphorus decompofes its acid very difficultly; fulphur does not unite with it, and does not form a fulphuret with its bafe.

11. All the acids eafily decompofe it, and difengage its carbonic acid with a brifk and fpeedy effervefcence. Butini fancied he obferved, that every acid difengaged a different quantity of gas; but it was becaufe the acids, being diluted with more or lefs water, in his experiments, different proportions of the carbonic acid were held in folution in the liquor. In thefe decompofitions magnefian falts are formed.

12. Carbonic acid was reputed, from the experiments of Bergmann and Butini, to have the property of rendering carbonate of magnefia foluble. But as they were unacquainted with this falt in its faturated and cryftallized ftate, it appears, from the proportions of the folution given by them, that their water impregnated with carbonic acid did not diffolve as much magnefia, as water without acid would diffolve of carbonate of magnefia fully faturated. On this folution, containing from a fixty-eighth to a two hundred and eighty-eighth of

its

its weight of carbonate of magnefia, Butini has made an interefting obfervation, particularly on the latter ftate of the folution. On heating it the falt feparates and is precipitated; but it re-diffolves in cooling. It was in this ftate the two chemifts abovementioned, Bergmann and Butini, faw the firft rudiments of carbonate of magnefia cryftallized by a flow and well-conducted evaporation.

13. Barites, ftrontian, lime, pot-afh, and foda, decompofe the carbonate of magnefia, and take from it the carbonic acid, for which they have a greater affinity. If folutions of thefe bafes be added to that of magnefia by carbonic acid, the magnefia is feparated in a pure ftate. Ammonia does not produce the fame effect: when this is added to a folution of carbonate of magnefia, it feparates the falt in an effervefcent ftate. In fact it will be feen, that magnefia decompofes the carbonate of ammonia, renders the latter cauftic, and fubfides as carbonate of magnefia to the bottom of the liquid in which this mixture is left. This is the reafon why I place the carbonate of magnefia before that of ammonia.

14. Carbonate of magnefia decompofes baritic, ftrontian, and calcareous falts diffolved in water, by neceffary double attractions. The magnefia feizes their acids, and the bafes fubfide in combination with its acid, as is proved by their increafe of weight, infolubility in water, and property of effervefcing with acids.

15. According

15. According to Bergmann's analyſis, the moſt ſaturated carbonate of magneſia contains,

Magneſia 45
Carbonic acid 30
Water 25

Butini, however, informs us, that this ſalt prepared for pharmaceutic purpoſes, when conſequently it ſhould contain leſs acid, is compoſed of the following proportions :

Magneſia 43
Carbonic acid 36
Water 21

I have found that well-cryſtallized carbonate of magneſia, obtained by the proceſs deſcribed in No. 4 of this article, much more ſoluble than that of Bergmann and Butini, and ſuſceptible of effloreſcence in the air, contained in a hundred parts,

Magneſia 25
Carbonic acid 50
Water 25

That which is prepared for the uſe of the ſhops, and not ſaturated, afforded me the following proportions :

Magneſia 40
Carbonic acid 48
Water 12

(See Annal. de Chim. tom. ii. p. 278—299.)

16. Carbonate of magneſia is prepared in the laboratory of the chemiſt only for the purpoſe of exhibiting its properties and affinities. In the arts it is not yet employed. In medicine,

that

that which is not completely faturated is given
as a gentle laxative or purgative. This is not
the preparation that fhould be ufed in cafes
where the indication is to abforb acidities in
the firft paffages. Macquer has juftly obferved,
that the gafeous carbonic acid, difengaged in
the ftomach by the action of the more powerful
acid it contains, diftends that vifcus, fills it
with wind, and may occafion much mifchief.
This, no doubt, is the caufe of the acute pains
fometimes experienced by thofe who have im-
prudently taken this kind of medicine when
they had an acid generated in the ftomach. In
this cafe, magnefia calcined, and deprived of
its carbonic acid, fhould be adminiftered; by
which all the evils, pains, naufea, and oppref-
fion, to which it may give rife, will be avoided.
It fhould be prefcribed in the calcined ftate, alfo
in cafes of perfons poifoned by the mineral
acids, and feveral other deleterious fubftances,
in which experience has proved it to produce
very good effects. Sometimes, too, it may be
employed diffolved in water by means of carbon-
ic acid, but to anfwer indications different from
the preceding.

SPECIES VII.

Carbonate of Ammonia.

A. Synonymy; History.

1. WE have long been in poffeffion of this falt, which has been prepared by chemifts under the names of *Englifh volatile falt*, becaufe it was firft made in England, and *concrete volatile alkali*, becaufe, having a very fenfible, though weak fmell of ammonia, it was thought proper to diftinguifh it on account of its form and folidity from the cauftic or volatile fluor alkali, which could be obtained only in a liquid ftate. But notwithftanding this nominal diftinction, chemifts had no idea of its different nature and compofition before the difcovery of Black. The prefence of *fixed air*, or carbonic acid, being once recognized in this falt, and confirmed by the inveftigations of Bergmann, and Chaulnes, Lavoifier, &c. not only was all obfcurity refpecting the formation of the pretended volatile fluor alkali, which had been taken to be the foregoing, altered or changed by lime, removed, but new light was inftantly thrown on a number of chemical properties belonging to faline fubftances, and all the errors previoufly committed refpecting their reciprocal attractions and decompofitions were diffipated.

It

It may be affirmed, that the difcoveries re-
lating to the nature of this falt, and its effects
in chemical phenomena, have eftablifhed a very
perfpicuous line of demarcation between all
that had been done before, and all that has been
done fince ; fo that moft of the ancient affer-
tions of chemifts concerning the volatile al-
kali in its two ftates, are actually fo many mif-
takes, which modern difcoveries have taught
us to correct.

2. When the compofition of the fuppofed
concrete volatile alkali was fully confirmed ;
when the uniform experience of all modern
chemifts had decided, that it was compofed of
an acid united to the cauftic volatile alkali,
different nàmes were given it, to diftinguifh it
from the volatile fluor alkali. Bergmann called
it *aerated volatile alkali* ; and it was named
*volatile mephite, cretaceous ammoniacal falt,
ammoniacal chalk*, according as the acid com-
bined with it was denoted by the appellations
of *aërial, mephitic*, or *cretaceous*. The term
carbonate of ammonia fucceeded thefe former
inexact or incorrect names, at the period when
the methodical and fyftematic nomenclature
was eftablifhed.

B. *Phyfical Properties; Natural Hiftory.*

3. THE truly pure carbonate of ammonia is
feldom very regular in the cryftalline form.
Moft frequently its cryftals are fo fmall that it
is

is difficult to determine their figure with ac-
curacy. Bergmann defcribes and reprefents
them as acute octahedra, the four angles of
which are truncated. Romé de Lifle has feen
them in compreffed tetrahedral prifms, termina-
ted by a dihedral fummit. Frequently they
exhibit little bundles of needles or very flender
prifms, arranged in fuch a manner as to repre-
fent herborizations, fern leaves, or the beards
of feathers. Thefe are the moft ufual product
of fublimation ; the truncated octahedron Berg-
mann obtained by faturating warm water with
this falt, ftopping the bottle that contained
the folution clofely, and expofing it to a great
degree of cold. It is true, he does not exprefs
himfelf very determinately refpecting their form,
faying, that he obtained only cryftals of little
regularity, which appeared to him to be octa-
hedra, truncated on four of their angles.

4. The tafte of this falt is a little acrid, am-
moniacal, and fetid ; it diffufes weakly, but very
perceptibly, the fmell of ammonia ; it turns
the colour of violets green, and the yellow tint
of turmeric brown.

5. It is not found in nature completely
formed or pure. It does not exift among fof-
fils ; it has not yet been met with diffolved in
waters ; it appears to be contained in animal
fubftances, particularly in putrid urine.

C. *Extraction;*

C. *Extraction; Preparation.*

6. IT is wholly prepared, or artificially fabricated in chemiſtry by a great many different proceſſes. Formerly it was extracted ſolely from dry animal ſubſtances diſtilled in retorts with a ſtrong heat. This product, then called *volatile ſalt* of hartſhorn, of vipers, &c. was entirely formed by the complete decompoſition of the animal ſubſtance; the ammonia, on the one hand, reſulting from the union of azote and hidrogen, and the carbonic acid, on the other, from that of the carbon with oxigen. It was always rendered impure by the animal oil, which was volatilized at the ſame time with the ſalt. Manufacturers frequently avail themſelves of this proceſs, by diſtilling rags, bones, or pit-coal, to obtain the ammonia required for combining with muriatic acid.

7. Carbonic acid gas, mixed with ammoniacal gas over quickſilver, alſo affords carbonate of ammonia, which as has been ſaid elſewhere, at firſt aſſumes the form of a white vapour, and afterward concretes in little bundles of cryſtals; but this mixture is made in too ſmall quantity to be employed for fabricating the ſalt. A more ſucceſsful mode is to expoſe large globes or jars of glaſs, impregnated or wetted with liquid ammonia, in the atmoſphere of carbonic acid gas, which covers wort in fermentation; at the expiration of a few hours the ſides of theſe

veſſels

veffels will be covered with well-faturated cryf-
tals of carbonate of ammonia, and, by in-
creafing the apparatus fufficiently, large quan-
tities may thus be prepared at once.

8. But the readieft and moft commodious
method of obtaining folid carbonate in abun-
dance, which is moft commonly practifed in
chemical laboratories, confifts in decompofing
ammoniacal muriate by carbonate of lime. For
this, one part of the former falt, and two of
the latter, chofen extremely pure, very dry and
powdered, are to be mixed in a glafs or marble
mortar. This mixture is introduced into a ftone
retort, to which a large ballon or a cucurbit of
glafs, is to be adapted as a receiver, which is to
be cooled by applying to its outer furface cloths
dipped in cold water, and frequently renewing
them. The retort is heated gradually to a
ftrong red-heat. In this procefs there is a
fuperfluous double attraction. The lime, which
alone would decompofe the muriate of ammo-
nia, feizes the muriatic acid; and the ammo-
nia, which is feparated from it, attacking the
carbonic acid difengaged at the fame time from
the lime, forms ammoniacal carbonate, which
fublimes and adheres in cryftals to the fides of
the receiver. It is effentially neceffary that the
fubftance employed be very dry, for without
this precaution no dry carbonate of ammonia,
or at moft very little, would be obtained; but
it would pafs over in a thick folution, from
which part would precipitate on cooling. After
this

this operation, muriate with excefs of lime remains in the retort : this is the *phofphorus* of Homberg which was mentioned in the hiftory of this latter falt.

9. The procefs juft defcribed was practifed in the great in England foon after the commencement of the feventeenth century ; whence the folid carbonate of ammonia furnifhed by it was long called *Englifh volatile falt.*

The chemifts in the Academy of Sciences at Paris fufpected, and foon difcovered, the mode of obtaining this falt, and it was prefently prepared in the French laboratories.

It is unneceffary to repeat here, that carbonate of ammonia may equally be prepared by decompofing ammoniacal muriate by means of the carbonate of pot-afh or of foda ; that of either of thefe only one part and a half at moft are neceffary, inftead of two of carbonate of lime, on account of the greater proportion of carbonic acid they contain, and the fmaller quantity of their bafes required to faturate the muriatic acid ; and that carbonate of lime is preferred only becaufe it is much more common and lefs expenfive. If the carbonate of ammonia produced by the firft operation be not very white and very pure, it is rectified by fublimation ; but this is never neceffary when the two falts have been chofen in a ftate of great purity.

D. *Action*

D. *Action of Caloric.*

10. The carbonate of ammonia, in which the alkaline properties are not completely concealed, as was faid above of the other carbonates, is extremely volatile. It fublimes at a heat little above that of boiling water. Thrown on a hot iron or brick, it melts, boils, and is reduced to a very light and fcarcely perceptible vapour. If you would fublime it thus, and purify it by this procefs, a very gentle heat muft be employed. It always cryftallizes badly and confufedly in this operation; which, however, does not decompofe it or feparate its principles.

E. *Action of the Air.*

11. This falt, when very pure, and well faturated, is not perceptibly altered in the air; in contact with it, it neither lofes nor abforbs water. When it appears to foften and grow moift in the atmofphere, it always contains an excefs of ammonia, which is obfervable by the brifknefs of its fmell. We cannot doubt, however, that the carbonate of ammonia is foluble in air, fince, on being left in an open veffel, it gradually decreafes in weight, and diffufes to a certain diftance the very perceptible fmell that characterizes it, which can proceed from nothing but its aërial folution.

2   F. *Action*

F. *Action of Water.*

12. The carbonate of ammonia is very foluble in water, and produces a confiderable degree of cold during its folution. Two parts of water, at ten degrees, diffolve a little more than one of the falt; water, at forty degrees, diffolves more than an equal weight; and when this folution is quickly and powerfully cooled, the falt cryftallizes, and exhibits the appearance of the regular figure defcribed by Bergmann. Boiling water fhould not be employed in this procefs, becaufe the carbonate of ammonia flies off with its vapour.

G. *Decompofition; Proportions of Principles.*

13. No combuftible fubftance has any action on the carbonate of ammonia, the heat neceffary to favour fuch action volatilizing the falt before it can take place; accordingly its carbonic acid is not difengaged by charcoal, and it is not decompofed by phofphorus.

14. It appears that fome metallic oxides can deprive it of its carbonic acid. All the acids, even the boracic, affifted by heat, difengage its acid with a more marked effervefcence than that of the carbonates of pot-afh and foda, becaufe it contains more acid than the two laft, as will prefently be feen. The theory of this decompofition is very fimple, and the fame with that of the decompofition of the carbonates already

ready examined. The only difference confifts in the effervefcence, which here exhibits bubbles much larger, and in greater abundance, than in the cafe of the two preceding falts, in confequence of the greater quantity of carbonic acid.

15. Barites, ftrontian, lime, pot-afh, and foda, decompofe carbonate of ammonia in a manner the reverfe of that of the acids, fince thefe bafes feize the acid, and fet the ammonia at liberty. In the dry way they all exhibit the fame phenomena, a difengagement of ammoniacal gas, and formation of carbonates. Even magnefia produces an equal effect by the help of a little time, according to the obfervation of Bergmann, which has led me to place the carbonate of magnefia before that of ammonia. Pot-afh and foda decompofe carbonate of ammonia without any apparent precipitation; only the former cryftallizes into carbonate of pot-afh, if the folutions were faturated. Barites, ftrontian, and lime, form copious precipitates of earthy carbonate. The other bafes, filex, alumine, zircone, have no action on this falt. Its folution diffolves glucine well, and in abundance; and carbonate of ammonia is fuccefsfully employed to feparate this earth from alumine, in analyzing ftones that contain both, as it was by Citizen Vauquelin in his analyfis of the beryl and the emerald. The folution of glucine, in liquid carbonate of ammonia, lets fall the earth on being expofed to the action of

heat,

heat, in proportion as the carbonate of ammonia is volatilized.

16. Carbonate of ammonia decompofes the aluminous and zirconian falts by a fuperfluous double affinity, as ammonia alone would effect the fame decompofition. It acts in part only on the magnefian falts, with which we know triple falts are formed by the ammonia. It decompofes the baritic, ftrontian, and calcareous falts, by a neceffary double affinity; for ammonia produces no alteration in thefe falts, and it effects their decompofition in this cafe only through the help of the affinity which the carbonic acid has for their earthy bafes. Accordingly, in thefe operations, carbonates of barites, ftrontian, or lime, are precipitated, though fometimes no precipitate is occafioned in the folution, on account of the great quantity of carbonic acid this falt contains, which diffolves the carbonate of barites that is formed. It was formerly fuppofed, that volatile alkali, had a greater affinity to the acids than the calcareous earth, becaufe the carbonate of ammonia was confidered as true volatile alkali; while at the fame time it was feen, that the ammoniacal falts were decompofed by lime: this led to the notion of *reciprocal affinities*. We now know by what error chemifts were long mifled from their ignorance of the carbonic acid, and how greatly it embarraffed their explanations.

17. According to Bergmann, a hundred parts of carbonate of ammonia well cryftallized contain:

Carbonic

Carbonic acid   45
Ammonia   43
Water   12

H. *Ufes.*

18. CARBONATE of ammonia is frequently ufeful in chemiftry for decompofing other falts. In manufactories it is prepared in the great by diftilling animal fubftances for fabricating muriate of ammonia, either by precipitating with it the calcareous muriate of the bittern in faltworks, or by combining it directly with muriatic acid, expelled by the fulphuric acid from muriate of foda.

In medicine, the carbonate of ammonia is frequently adminiftered as an energetic and powerful remedy. It is ufed as a ftimulant and ftrengthener to patients difpofed to faint, being given to them to inhale by the nofe. In England, volatile oils are mingled with it, to render it aromatic; and the infides of little bottles of coloured glafs, which are kept well ftopped, are coated with it. It is confidered as a fpecific againft the poifon of the viper, being taken internally; but moft of the cafes in which it has been adminiftered, and where its action was deemed fpecific, appear to have been of fuch a nature, that the patients would have recovered fpontaneoufly, according to the refults of Mr. Fontana's inquiries. The carbonate of ammonia has been reckoned likewife in the number of anti-

anti-venereal medicines, and of remedies for cancers; but in both thefe refpects its virtues are at beft extremely queftionable. In general this falt is ranked among the detergents, diuretics, diaphoretics, ftimulants, and attenuants.

SPECIES VIII.

Ammoniaco-magnefian Carbonate.

1. I DISTINGUISH the ammoniaco-magnefian carbonate as a fpecies, from an analogy, which has held good in all the genera of falts I have hitherto defcribed, and becaufe this falt is manifeftly formed on many occafions. If we be not yet able, in the prefent ftate of the fcience, to defcribe the ammoniaco-magnefian carbonate with as much precifion as all the preceding fpecies of carbonates, it is indifpenfably requifite to point out the circumftances under which this falt is formed, and to prove the reality of its exiftence, in order to make the fyftematic feries of faline fubftances more complete, and to excite chemifts to a careful examination of the properties of this new fpecies, which no author has yet mentioned.

2. When the carbonate of ammonia is decompofed by means of magnefia, in the moift way, by leaving thefe two fubftances in contact in a clofe veffel, a complete decompofition is

not

not effected, but an ammoniaco-magnefian tri-
ple carbonate is formed. The fame combina-
tion takes place when we precipitate a folution
of carbonate of magnefia in acidulated water
by means of pure ammonia; and alfo when we
precipitate a folution of ammoniaco-magnefian
fulphate, nitrate, or muriate, by means of car-
bonate of pot-afh, or carbonate of foda. Thus
there are four chemical proceffes, one of the
conftant products of which is the fpecies of tri-
ple falt of which I am here fpeaking.

3. Though the properties of this carbonate
with a double bafe, or combination of two car-
bonates, are not yet known, I have already
feen, that it cryftallizes differently from either
of the falts which compofe it; that it follows
a diftinct law of folubility and decompofition;
and that it is entirely decompofable by fire, by
the acids, and by barites, ftrontian, lime, pot-
afh, or foda.

SPECIES IX.

Carbonate of Glucine.

A. Hiftory.

1. THE carbonate of glucine is one of the
leaft known fpecies of this genus, as this falt
lately difcovered by citizen Vauquelin, has
hitherto been examined only by him, and in
very fmall quantities. It is, however, one of
the

the falts of this new bafe which he has ftudied, and the properties of which he has beft afcertained, becaufe they moft readily offered themfelves to his inquiries.

B. *Phyfical Properties.*

2. THIS falt is in a white, dull, clotty powder, never dry, but foft and greafy to the touch. It is not faccharine, like the other falts of glucine, but void of tafte. It is very light, and has not yet been found native.

C. *Preparation.*

3. THE carbonate of glucine is prepared artificially, either by expofing this earth to the air from which it attracts the carbonic acid, or by precipitating foluble falts of glucine by alkaline carbonates. The precipitate formed is to be well wafhed, to free it from all the extraneous falt it may contain, and then thoroughly dried in the open air.

D. *Action of Caloric.*

4. THE action of fire eafily expels the water and carbonic acid from this falt, and reduces it to the ftate of pure and cauftic glucine, that is to fay, to its bafe deprived of acid.

E. *Action*

E. *Action of Air.*

5. It is completely unalterable in the air.

F. *Action of Water.*

6. It is infoluble in water; and, in this re-
fpect, it even differs from the greater number
of other carbonates, which are rendered foluble
by means of their acid. Citizen Vauquelin
could not accomplifh its folution in water fatu-
rated with carbonic acid.

G. *Decompofition; Proportion of its Principles.*

7. The carbonate of glucine is decompofable
by all the acids of the preceding falts, which
rapidly expel from it the carbonic acid with
a ftrong and brifk effervefcence, and feize upon
its bafe.

8. It is decompofed in the oppofite mode by
the alkalis and alkaline earths, which take from
it its acid. Ammonia, firft decompofing it,
readily diffolves its bafe, the glucine; becaufe
the carbonate of ammonia, formed on this oc-
cafion, has the property of diffolving this earth
eafily and in abundance.

9. Its action on any of the falts hitherto de-
fcribed has not yet been determined; it muft be
capable of decompofing the calcareous magne-

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fian, and ammoniacal falts, in confequence of the double affinity of its carbonic acid.

From his firft experiments on this falt, Citizen Vauquelin has concluded that it contains about a fourth of its weight of acid.

H. *Ufes.*

10. THOUGH the little carbonate of glucine hitherto procured has not permitted us yet to endeavour to render it ufeful, it is obvious that it may be employed in chemiftry, after having been precipitated from a foluble falt of glucine by an alkaline carbonate, for obtaining this earth pure, fince it eafily lofes its acid by calcination.

SPECIES X.

Carbonate of Alumine.

1. THIS is another fpecies of carbonate yet little examined. If we except the few words faid of it by Bergmann in various parts of his works, and what I began to make known refpecting it in my Elements, chemifts have hitherto neglected to treat of this falt.

2. When we precipitate aluminous falts, particularly the triple acidulous fulphate of alumine, by alkaline carbonates, we find, that the precipitation

precipitation is effected without effervefcence, or with a flight effervefcence, which proves, that the carbonic acid is not evolved: and as it cannot remain combined with the alkali, which is attracted by the fulphuric acid ; it is very evident, that it remains fixed in the precipitated alumine : accordingly the liquor, after this precipitation, contains a portion of true carbonate of alumine, which fubfides in a few hours, or in a few days, in confequence of the evaporation of the carbonic acid, which held it in folution.

3. Clay, or the native mixture of alumine, filex, &c. contains, befides, a portion of carbonic acid, which is difengaged by expofure to a ftrong fire. That of Cologne, as Bergmann informs us, yields feveral times its own bulk of this acid, mixed with a fmall portion of hidrogen gas. Thus the native alumine of earths appears to be faturated with carbonic acid ; and it is in confequence of this, that fat, clayey earths, when treated with acids in order to analyze them, are found to be effervefcent, even without containing any carbonate of lime, in their aluminous part.

4. No further examination has yet been made of the properties of this combination, which appears, however, neither to affect a cryftallized form, nor in its characteriftics to have any thing very diftinct from pure alumine, for which it is employed, as they are continually confounded

together;

together : as an acidiferous fubftance, however, it may act a confiderable part in vegetation.

Species XI.

Carbonate of Zircone.

1. Mr. Klaproth, who difcovered zircone to be a peculiar earth, has faid nothing of its union with carbonic acid. Citizen Guyton, in his analyfis of the hyacinths of Expailly, imagined, that this earth would not diffolve in carbonic acid. Citizen Vauquelin, on the contrary, in his comparative analyfis of the French or Expailly hyacinths with thofe of Ceylon, pofitively afferts, that the carbonic acid combines with zircone.

2. It is eafy to reconcile the two chemifts on this fubject. Citizen Guyton employed a very acid folution of zircone to be precipitated with alkaline carbonates ; and citizen Vauquelin, in his procefs, ufed muriate of zircone, firft evaporated, and then re-diffolved in water. Both too agree, and this conftitutes a ftriking fimilarity in the refults of their experiments on this head, that zircone, at firft precipitated by carbonates, re-diffolves in an excefs of thefe falts ; a fact, which proves the attraction of zircone for the carbonic acid.

3. When a folution of muriate of zircone is decompofed by a folution of any alkaline carbonate,

bonate, the earth precipitates, without any effervefcence taking place: which proves, that the carbonic acid unites with the zircone while the alkali combines with the muriatic acid.

4. If the precipitate of zircone thus obtained be collected, and heated in clofe veffels, it gives out carbonic acid gas.

5. It affords the fame product when treated with acids, particularly the muriatic or nitric, both of which diffolve this earth. The union of zircone with carbonic acid, therefore, and the exiftence of carbonate of zircone cannot be doubted.

6. From the analyfis of citizen Vauquelin, one hundred parts of this falt, from which its acid and its water are eafily expelled by the action of caloric, contain 55, 5 of zircone, and 44, 5 of water and acid, the proportions of which he has not afcertained.

7. One of the moft remarkable characters of the carbonate of zircone, according to the fame chemift, is its combining very eafily with alkaline carbonates, and becoming very foluble with them. It then forms triple falts, of which there appear to be at leaft three fpecies; namely, a carbonate of pot-afh and zircone, a carbonate of foda and zircone, and a carbonate of ammonia and zircone.

8. Of thefe three falts I fhall treat only of the laft as a diftinct fpecies, becaufe it is the only one of them of which any properties have been noticed by citizen Vauquelin, he having merely

<div align="right">announce</div>

announced the exiſtence of the other two; be-
cauſe it would be ſuperfluous to multiply the
ſpecies of ſalts; and becauſe it is by no means
abſolutely neceſſary to diſtinguiſh all thoſe of
which we have barely had a glimpſe, and which
would load the ſcience of chemiſtry, without
adding to its real wealth, while their charac-
teriſtic properties remain not ſufficiently known.

Species XII.

Ammoniaco-Zirconian Carbonate.

1. WHEN a ſolution of muriate of zircone is
precipitated by carbonate of ammonia, at firſt
a tolerably copious white precipitate is formed.
On continuing to add more of the ſalt, the pre-
cipitate diſappears, and the liquor becomes clear.
Thus the carbonate of ammonia begins with
ſeparating carbonate of zircone, and afterward,
when added in exceſs, re-diſſolves it, ſo that an
ammoniaco-zirconian carbonate is formed.

2. The experiment juſt deſcribed, is a proof
that this triple ſalt is much more ſoluble than
the carbonate of zircone; ſince the latter, which
at firſt precipitates, afterward re-diſſolves in
proportion as it combines with the carbonate of
ammonia.

3. The ammoniaco-zirconian carbonate is
very eaſily decompoſed by the action of fire.
When a ſolution of it is heated over the fire to
a ſtate

a state of ebullition, the carbonate of ammonia is volatilized, the liquor becomes milky, and the carbonate of zircone precipitates. To effect this decomposition completely, it must be heated a long time, till all the carbonate of ammonia is volatilized.

4. The fixed alkalis, and the powerful earthy bafes, barites, ftrontian and lime, decompofe this falt. Citizen Vauquelin remarks, that pure or cauftic ammonia does not precipitate its folution, which in fact it ought not. This remark he advances as a proof, that the falt diffolved is actually a triple falt : for, if it were only a fimple folution of carbonate of zircone in an excefs of carbonic acid, it is very obvious, that the ammonia, taking up this excefs of acid, would precipitate the carbonate of zircone.

Species XIII.

Ammoniaco-glucinian Carbonate.

1. I HAVE remarked in the hiftory of glucine, and in that of feveral fpecies of faline fubftances, that glucine was foluble in a lixivium of carbonate of ammonia ; and that this property, at the fame time that it was very ufeful for characterizing this earth, was very advantageous as furnifhing a method of feparating it from alumine, which does not diffolve in this

4   ammoniacal

ammoniacal falt as glucine does. This was one of the means that affifted citizen Vanquelin in the difcovery of glucine, and one of the characters by which he recognized its exiftence and peculiar nature.

2. This folubility of glucine in the lixivium of carbonate of ammonia, while it fhows a remarkable attraction between the two fubftances, proves that the earth participates in the tenacity of ammonia for the carbonic acid; and by this participation, forms a fpecies of triple falt, or falt with two bafes, which I call am moniaco-glucinian carbonate. It is evident that this falt, the exiftence of which is yet new to chemifts, and no property of which has yet been defcribed by citizen Vauquelin himfelf, who firft made it in his experiments, can have none of its peculiar characters known, except its folubility in the fame quantity of water as contained the carbonate of ammonia, with which it is prepared.

ARTICLE XIII.

Review of the general Properties that Salts exhibit, and of the Comparifon that may be made between them.

1. THOUGH the hiftory of the genera and fpecies of faline fubftances, which I have juft

defcribed

defcribed, required to be entered into at length, and with confiderable minutenefs, to be treated in a manner fuitable to the prefent ftate of our knowledge, the reader muft have perceived, even by the order which I have followed, that it was poffible to refer their properties to a cer-tain number of general terms, which together, conftitute the true faline character.

2. In fact, the favour of falts or their im-preffion on our organs of tafte,—the cryftalliza-tion, by means of which art gives them figure, —fufibility, or the influence which an accumula-tion of caloric exerts on them,—efflorefcence and deliquefcence, or the manner in which they are acted upon by air ;—and laftly, their folubility or relation to water, are the five moft decifive characters of thefe fubftances, and, among the properties treated of in this fection, have oc-cupied the moft of our attention. To thefe might be added their fpecific gravity and pri mitive figure : but we have not yet a fufficient number of pofitive facts on thefe two properties, to allow us to derive from them general notions, fuch as I purpofe to offer in this place. I fhall not pafs over them in filence, however ; but it will appear, that they by no means furnifh a comparifon equally ufeful with what I fhall be able to eftablifh on the five properties mentioned above. Each of thefe, therefore, I fhall pro-ceed to review under a feparate head.

SECTION

SECTION I.

Of the Sapidity of salts compared with each other.

3. FORMERLY the tafte was fuppofed to be capable of diftinguifhing the character and general nature of faline fubftances. Savour was fo particularly afcribed to them, that it feemed fufficient to characterize them, and make them known. In thofe days, as it was enough for a fubftance to be fapid to be ranked among falts, an unlimited number of fubftances were referred to this clafs, which poffeffed no other property capable of placing them in it; and as no faline fubftance was thought to be void of favour, a great many fubftances were excluded from this order, which ought to have made a part of it.

4. Hence that error fo long committed in mineralogy, by which feven or eight principal fpecies of falts continued for fuch a confiderable period to be claffed among ftones : a fault which has not yet been corrected, except in the modern method adopted by the fchool of mines in France. Hence too, the practice of ranking acids and alkalis as very acrid fubftances in the clafs of falts : and even the habit chemifts had acquired of confidering thefe acids and alkalis, in confequence of their very powerful fapidity, not only as falts, but as the ftrongeft and moft

potent

potent falts, as thofe which even imparted their energy to others.

5. At prefent it would be improper to confider in this manner the relations that tafte bears to faline properties. Sapidity cannot continue to be placed at the head of the faline characteriftics, as the fign of the powerful attraction or affinity it exerts on our organs: this action belongs to other fubftances, as much, and often more than to falts, for acids and oxides, which are no longer to be confidered as faline fubftances, exert it in a much more eminent degree than falts.

6. The leaft reflection on this difference, and on its caufe, will teach us, that it muft be owing to the ftate of the chemical affinities of very fapid bodies and faline fubftances compared with each other. The former in fact, have always a great force of combination, becaufe they tend to unite with a great number of bodies: in the falts, on the contrary, this force is fatisfied; the bafes neutralize the acids, according to the ancient language of chemiftry, that is to fay, exhauft their tendency to combination, faturate their power of union, and enfeeble the force with which they attack different fubftances; the moderns fay much of the bafes weakened by the acids, where they admit a reciprocal faturation. This confideration, much more precife than was formerly adopted in chemiftry, fhows that falts, far from being the moft fapid fubftances, muft on the contray, have the leaft decided

cided favour, as being compounds moſt per-
fectly ſaturated.

7. It is now eaſy to underſtand, why, in enu-
merating the properties of moſt ſalts, the ex-
preſſion of perfect inſipidity has been uſed, or
a mean ſapidity has been indicated by the ſen-
ſation which is excited in moſt men ; a favour
ſufficiently acrid, ſtrong, and potent to act as a
cauſtic, being rarely mentioned. There are,
however, among the ſalts, the materials of which
adhere together but ſlightly, ſome compounds
of a ſtrong and violent taſte : but it is obſer-
vable, that it never extends to cauſticity. It
is no leſs remarkable, that the moſt ſtriking in-
ſipidity is frequently found among thoſe ſaline
compounds, the component parts of which have
the ſtrongeſt ſapidity and greateſt cauſticity in
a ſeparate ſtate, as concentrated ſulphuric acid,
pot-aſh, ſoda, and barites : and this contraſt,
this marked oppoſition, affords a proof, that the
attraction reciprocally exerciſed by theſe ſub-
ſtances on each other is the cauſe of their taſte
having diſappeared.

8. Although it is a general law in chemiſtry,
that compounds have properties very different
from thoſe of their component parts, becauſe
the attraction of compoſition actually changes
the properties of the bodies on which it has
acted, there are, however, ſome ſhades of ſapidity,
if not ſimilar, at leaſt analogous, ariſing from the
combination of a particular acid with different
baſes, or of a particular baſe with very different
acids.

acids. Thus the nitric acid imparts a coolnefs to nitrates in general; the phofphoric acid, a fweetifh tafte to phofphates; the fulphureous, a favour of burning fulphur to fulphites; the muriatic, a faltnefs to muriates. Thus alumine exhibits an acerb or aftringent favour in all falts; glucine communicates a faccharine tafte to the falts compofed of it; magnefia, a bitter tafte; and zircone, a rough and as it were a metallic tafte. On this fact, however, we muft not build any point of doctrine, for there are exceptions too numerous, and too ftrong, for it to be confidered as general. The falts which barites forms are fome of them infipid, fome acrid; yet both are equally deleterious. Lime affords extremely acrid bitter falts, and falts perfectly void of favour.

9. In falts, the tafte is frequently found united with other properties, which prettly clofely follow its weaknefs or ftrength. Thus it is a general rule, that all very fapid falts are at the fame time very foluble in water; and on the contrary, thofe which are more or lefs infipid, have at the fame time a more or lefs decided infolubility. It would be difficult to find an exception to this rule: we may even carry it fo far as to fay, that the very acrid falts are fo extremely foluble, that they powerfully attract the water in the atmofphere, and are characterized by a fpeedy deliquefcence.

10. We find likewife a pretty ftrong analogy, a relation fufficiently marked, between the fa-

vours

vours of falts and their medicinal properties.
There is lefs conftancy, however, and lefs cer-
tainty in this analogy, than in the preceding;
or at leaft it has not been ftudied with the fame
exactnefs; and it is not fo eafy to be known or
determined. In general, it is true, that every acrid
bitter falt is purgative and attenuant; every
falt that poffeffes a bitter favour, imparts to water
the character of hardnefs: but it muft not be
forgotten, that the fulphate and carbonate of
barites, though perfectly infipid, are poifonous.

SECTION II.

Of the Cryftallization and Form of Salts.

11. CRYSTALLIZATION in chemiftry fignifies
either the property fubftances have of affuming
a regular form, or the art of making them take
it. This form is given them by the help of cer-
tain circumftances, the conjunction of which
appears to be neceffary to favour the arrange-
ment of the molecules. Almoft all minerals
enjoy this property; but there is no fubftance
in which it acts with fuch energy, as in thofe
that are faline. The circumftances which favour
it, and without which it cannot take place, are
reducible, with refpect to falts, to the two fol-
lowing. 1. Their molecules muft be divided
and kept apart by a fluid, that they may after-
ward

ward tend toward each other, or attract each other reciprocally by thofe faces which have the greateft relation to one another. 2. It is neceffary, that the fluid which keeps their integrant parts feparate, fhould be gradually abftracted, and ceafe to keep them apart.

12. From this fimple expofition it is eafy to conceive, that cryftallization is operated folely by virtue of the attraction between the molecules, or the affinity of aggregation, which tends to bring them together, and make them adhere to each other. Thefe confiderations lead us to imagine, that the integrant parts of a falt have a form peculiar to them, and that the different figure which every faline fubftance affects in its cryftallization, depends on this primitive form of its molecules. They equally induce us to believe, that the polyhedral figures belong to the molecules of falts having unequal fides, or fome faces of greater extent than others; thefe molecules muft have a tendency to approach and unite by thofe faces which are the moft extenfive. Suppofing this, it will be eafy to conceive, that, on abftracting the fluid which keeps thefe molecules apart, they will unite by thofe faces which are beft adapted to each other, or which bear the ftrongeft relation; and if this fluid quit them gradually, and fo as to leave the faline particles time to arrange themfelves, if we may ufe the expreffion, and prefent themfelves fuitably to one another, the cryftallization will be regular; while on the contrary, too fpeedy

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an abftraction of the feparating fluid will force them to come together fuddenly, and as we may fay by the firft faces that offer, in which cafe the cryftallization will be irregular, and the figure difficult to be afcertained. And if the evaporation be altogether fudden, the falt will ever form only a concrete mafs, which will have fcarcely any cryftalline appearance.

13. As elements of cryftallization we muft alfo confider the attraction of the faline molecules for water and for caloric, and the variations of this attraction, which take place in proportion to the quantity of thefe two fluids compared with that of the faline matter ; the relation this attraction bears to that which takes place between the molecules of the falt, and the difference between thefe two ; and laftly, the attraction of the fides of the veffel for thefe molecules. Thefe are fo many caufes which give rife to various fecondary forms in falts, by producing different decrements, more or lefs regular, in the layers of their united molecules.

14. The art of cryftallizing faline fubftances is built on thefe fundamental truths. All falts are fufceptible of it, but with more or lefs facility : there are fome which cryftallize fo eafily, that we may conftantly fucceed in making them affume the regular form at pleafure ; others require more precaution and care ; and laftly, there are fome which it is fo difficult to obtain in this ftate, that we have not yet been able to effect it. It is by ftudying thoroughly the circumftances

peculiar

peculiar to each falt, that we fucceed in making
them cryftallize. One principal condition for
carrying this operation into effect, is to diffolve
the faline fubftance in water ; but there are falts
fo little foluble by any means we can employ,
that it is almoft impoffible to procure them to
unite afterward in a regular form : fuch are the
fulphate, carbonate, and fluate of lime, and
fulphate of barites. Nature every day prefents
to us thefe earthy neutral falts cryftallized very
regularly, but art can imitate her only by the aid
of a very long fpace of time. There are even
many diftinguifhed natural philofophers, who
do not yet believe the practicability of the pro-
cefs mentioned by Mr. Orchard of Berlin, by
means of which he fays he has produced cryf-
tals of calcareous carbonate. This ingenious
procefs confifts in paffing water, which has ftood
a long time on falts very little foluble, through
a very narrow gutter, and procuring its evapora-
tion with much flownefs.

15. There are other faline matters on the con-
trary, which are fo foluble, and adhere fo
tenacioufly to water, that they do not part
with it without great difficulty ; and it is like-
wife very difficult to obtain them in regular
forms. This takes place with all the deliquefcent
falts, as the calcareous magnefian nitrates and
muriates. It is but with great difficulty that
we can furmount the attraction thefe falts have
for water ; and if we fucceed in feparating them
from it by a great effort, it is only for a few

moments that this feparation takes place, for thefe falts quickly lofe their cryftallized ftate.

16. It cannot be doubted, that every falt has its proper and peculiar mode of cryftalliz-ing; or, which is the fame thing, that it has in its primary molecules a determinate form, dif-ferent from that of every other. This unquef-tionably is the firft caufe of the remarkable differences that exift between the cryftals ob-tained. The bafes and acids which conftitute them, from the falino-earthy fubftances to the moft powerful acids, have, for the moft part, no determinate figure : there are only fome cir-cumftances, which, without altogether deftroy-ing their diftinguifhing properties, make them affect a cryftalline form, as takes place in the oxigenated muriatic acid, and in the concrete fulphuric. The cauftic alkalis, however, cryf-tallize in laminæ, according to the obfervation of citizen Berthollet; and the acid of borax exhibits the fame lamellated form to every che-mift. Moft of thefe falifiable or falifiant fub-ftances do not affume any regular form in our laboratories, either becaufe they are in fact not fufceptible of it, or becaufe our means are in-fufficient to give them fuch a form : but their compounds, the falts, all affect a regular form, and art has attained the power of making it dif-appear and reproducing it at pleafure in moft of them. When we confider this property, altoge-ther different from what their conftituent parts poffefs, is it poffible to determine, whether it

4   depend

depend on the acids, or on the alkaline bafes by which they are neutralized? It appears, that it cannot be afcribed exclufively to either, for the fame acids with different bafes, often form falts very different in figure; while in other inftances, the fame bafe, combined with different acids, exhibits equal diffimilitude in its cryftals: it is to the total change of the properties of every new faline compound therefore, that the diverfity of forms affumed by thefe compounds muft be attributed.

17. There are three general neans of cryftallizing falts in our laboratories.

A. Evaporation. This procefs confifts in heating a faline folution, fo as to reduce the water which keeps apart the molecules of the falt into a ftate of vapour. The more flowly this evaporation is conducted, the more regular will the cryftallization be. It is thus we proceed for obtaining cryftals of fulphate of pot-afh, muriates of pot-afh and foda, fulphate of lime, and carbonate of magnefia. Their figure has very little regularity, if the water be evaporated too haftily, as by a boiling heat: but by keeping faline folutions of this fort in a fand-heat of forty-five degrees, or thereabout, very beautiful and very regular cryftals are conftantly obtained in a longer or fhorter fpace of time; and there is fcarcely any falt which may not be made to affume a very diftinct form by this procefs, if it be fkilfully conducted.

B. Refrigeration is fuccefsfully employed for

fuch

fuch as are more foluble in hot water than in cold. It may readily be conceived, that a falt of this kind muft exhibit this phenomenon, fince it ceafes to be equally foluble in water of which the temperature is diminifhed ; fo that the portion, which remained diffolved only, by means of the higher temperature, will feparate by degrees as the liquor cools ; and when this is completely cooled, it will retain in folution only fuch a quantity as cold water would diffolve. It is the fame with this fecond procefs, as with the firft. The more flowly the water cools, the more will the faline molecules be enabled to approach each other by thofe faces which are moft fuitable, and a very regular cryftallization will be obtained. For this reafon, a certain degree of heat muft be kept up for fome time under faline folutions, diminifhing it gradually, if neceffary, to the freezing point. It muft be obferved, that all the falts, which may be made to cryftallize in this manner, are much more foluble in general than thofe, for which the preceding method is employed : and as they are diffolved at firft in boiling water, if this be fuddenly cooled, it will let fall in a fhapelefs mafs all the falt that was diffolved by means of the boiling heat : on the contrary, if the folution be placed, while very hot, on a fand-bath, and care be taken to conduct the refrigeration flowly, the cryftallization will be very regular. Such is the mode of obtaining fulphate of foda, nitrate of pot-afh, the carbonates of foda and pot-

afh,

afh, ammoniacal muriate, &c. in beautiful cryftals.

C. The third method of cryftallizing falts is by fubjecting them to fpontaneous evaporation. For this, a very pure faline folution is expofed to the temperature of the atmofphere in capfules of glafs or ftone ware, which muft be covered with gauze, to prevent any duft from falling into the liquor, without hindering its evaporation. For this operation, a feparate chamber or garret fhould be chofen, and ufed for no other purpofe. The folution is left thus expofed to the air, till cryftals are perceived in it, which fometimes does not take place in lefs than four or five months, or even longer with fome falts. This procefs ufually fuccceds better than either of the others for obtaining cryftals very regular in their figure, and of confiderable bulk. It ought to be employed in general for all falts, if time would allow, becaufe it is the means of having them perfectly pure. It is thus we fhould proceed for nitrate of foda, muriate of foda, borax, the triple fulphate of alumine, fulphate of magnefia, ammoniacal fulphate, nitrate of ammonia, &c.

18. On fome occafions a combination of thefe procefes may be advantageous, particularly for obtaining cryftals of very deliquefcent falts, as the calcareous and magnefian nitrates and muriates, &c. The folutions of thefe being brifkly evaporated, are expofed immediately to a great degree of cold; but this method never affords

any

any but irregular cryftals, and fometimes con-
crete maffes of no regular form. If we have
not yet arrived at the means of cryftallizing a
pretty confiderable number of neutral falts, it
is becaufe we have not exactly afcertained the
degree of concentration, to which their refpec-
tive folutions ought to be reduced, in order to
furnifh cryftals. This labour, eafy in itfelf,
and requiring nothing but time and patience,
has not yet been completely purfued by che-
mifts. It is from the fpecific gravity of folu-
tions, that we fhould obtain thefe data, which
would be of great utility to the chemical ope-
rator; and this plan has already been adopted
with regard to faline matters, in feveral great
manufactories, where an hydrometer is ufed with
fuccefs for determining the point of cryftalliza-
bility for faline liquors, as water containing
common falt, falt-petre, alum, &c.

19. Befides thefe different means of cryftal-
lizing falts, there are feveral circumftances which
favour this operation, and the influence of which
it is neceffary to know how to appreciate. A
flight motion is fometimes of ufe to bring on the
cryftallization of a falt, when it had failed to
take place. Thus if we fhake a capfule filled
with a faline folution, in which no cryftals ap-
peared, or even remove it to a different place,
we fhall frequently find cryftallization come on
a few moments after the flighteft agitation. I
have already remarked, that this phænomenon
occurs particularly with the nitrate and muri-
ate

ate of lime. The contact of air feems often to be neceffary to the formation of cryftals. A folution, evaporated to the point requifite for cryftallization, many times affords no cryftals in a bottle clofely ftopped, while, if expofed to the air in a capfule, cryftals will be feen to form in it very fpeedily. This obfervation was made with great accuracy by Rouelle the elder. The form of the veffel, and the plunging of foreign bodies into faline folutions, have alfo much influence on cryftallization. The firft of thefe circumftances affects the figure of the cryftals, and produces in it a very great variety; for this reafon threads, or little fticks, are placed with advantage in the capfules, in which the cryftallization is performed, for the purpofe of obtaining regular cryftals. In this cafe the cryftals are precipitated on the threads, and as the furface on which they repofe has very little extent, they have commonly the greateft regularity of figure, while in attaching themfelves to the oblique, irregular, uneven fides of the earthen pans, or other veffels commonly employed for this ufe, they are more or lefs truncated and irregular.

The plunging of foreign bodies into faline folutions, has frequently another advantage; they determine the formation of the cryftals, which would have been much flower without their prefence. Thus a bit of wood, or a ftone, thrown into a brine fpring, becomes a bafe, on which the water depofits cryftals of muriate of foda.

foda. It is from obferving this phenomenon that fome chemifts have propofed to throw a faline cryftal into a folution of a falt, which does not cryftallize eafily; and many have af-ferted that this practice favoured the produc-tion of cryftals of falts very difficult to be ob-tained in a regular form. Thefe are the princi-pal caufes which influence cryftallization, but no doubt there are others, which future obfer-vation will make known to chemifts.

20. The feparation of a falt from the water which kept it in a ftate of folution cannot be effected in a regular manner, without a part of this fluid being retained by the falt. We may convince ourfelves of this, by taking a falt re-duced to powder by means of heat, as calcined fulphate of alumine, or borate of foda, or dried fulphate of foda, diffolving it in water, and cryftallizing it. By this operation we fhall find the falt augmented, and in fome cafes to double its quantity; that is to fay, one part of falt thus treated, will give two parts of cryftals. Chemifts have concluded from this phenome-non, that a falt well cryftallized, contains more water than the fame falt deprived of its form by the action of air or fire: and they have called this water, which is foreign to its effence as a falt, but neceffary to its cryftalline form, the *water of cryftallization*, becaufe it is in fact one of the elements of their cryftals; for when they are deprived of this water, they lofe both their tranfparency and their regular figure.

Different

Different falts contain a greater or fmaller quantity of thier water of cryftallization. There are fome which contain half their weight, as fulphate of foda, carbonate of foda, and the triple fulphate of alumine: others have but a fmall portion, as nitre, muriate of foda, &c. This relative quantity of water of cryftallization, has not yet been determined with accuracy in all the very cryftallizable falts. It may be extricated from falts without any way altering their intrinfic nature; and it is itfelf perfectly pure, and fimilar to diftilled water.

21. As by what has hitherto been faid on the cryftallization of falts, it is proved, that the different faline fubftances are not cryftallized by the fame proceffes, and follow different laws in the formation of their cryftals, it is clear, that we may avail ourfelves of this circumftance to effect their feparation. Thus a falt cryftallizable by refrigeration, may be obtained very accurately feparated from another falt, which is capable of being cryftallized only by continued evaporation; as is done with the waters of Lorraine, which contain muriate and fulphate of foda. Notwithftanding this it frequently happens, that two falts, diffolved in the fame water, are often found more or lefs mingled together, whatever difference there may be in the manner in which they cryftallize; and that we muft have recourfe to feveral fucceffive folutions and cryftallizations, to obtain them pure and unmixed. This obferva-

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tion is ftill more important with regard to thofe falts, which refemble each other in their laws of cryftallization; they being much more diffi-cult to feparate from each other, particularly if they be in greater number. For inftance, if the fame water contained four falts equally cryftallizable by evaporation and refrigeration, it would be impoffible to feparate them by one or two fucceffive cryftallizations, and the pro-cefs muft be repeated a confiderable number of times, to enable the flight fhades of difference that exift between their cryftallizabilities to act: for it muft be remarked, that, though two or more falts are equally cryftallizable by refri-geration or evaporation, there exifts percepti-ble fhades between them, which modify, as we may fay, the general law; without which they would always cryftallize together, and we could never obtain them thoroughly feparated; but this we can do, even with the falts that moft refemble each other in cryftallizability. There are only a few, which make an exception to this general rule, becaufe they have a parti-cular adherence or remarkable affinity for each other; fuch are in general the falts formed by the fame acid, and at the fame time cryftalli-zable by the fame procefs; but thefe fingular adherences of falts to each other have not yet been fufficiently obferved, though it is a fub-ject ftrongly meriting the attention of che-mifts.

22. In

22. In fine, to conclude this abridged hiſtory of the cryſtallization of ſalts, I ſhall add, that there is another method of obtaining them in cryſtals. This is by precipitating them from their ſolutions by a ſubſtance which has a greater affinity than they have for water. Alcohol poured into a ſaline ſolution produces this effect with moſt neutral ſalts, ſuch only as are ſoluble in this liquid being to be excepted. The ſame phenomenon of the precipitation of ſaline cryſtals, takes place in the mixture of ſome ſalts of very different ſolubility, and even ſometimes on the mixture of different ſaline ſolutions. In general cryſtals are precipitated from ſolutions of alkaline ſalts by the lixivium of potaſh, or cauſtic ſoda, provided this lixivium be ſufficiently concentrated.

Section III.

Of the Fuſibility of Salts, or the Action of Fire on theſe Subſtances.

23. THOUGH the title of this diviſion indicates, that it treats of fuſibility we muſt comprehend in this term all the effects, which ſalts are capable of undergoing from the action of fire. In this action there is a ſeries of phenomena different from each other, and which are frequently independent of fuſibility ; beſides, the fuſion which ſaline ſubſtances experience, is often but one of the effects, that pre-

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cede or accompany other alterations, produced by the accumulation of caloric in thofe fub-ftances. On generalizing the whole of thefe alterations, of which falts are fufceptible by the action of fire, I find they may be reduced to fix kinds, to which we may refer all faline fubftances: 1ft, aqueous fufion: 2d, igneous fufion: 3d, decrepitation: 4th, fimple volatilization: 5th, volatilization with alteration: 6th, decompofition. Let us take a brief view of each of thefe actions, and fee what it contains ufeful to be known with refpect to the hiftory of falts.

24. By aqueous fufion we mean that liquefaction, which is owing to the water that enters into the cryftallization of thefe falts. When this water is abundant, when it extends for inftance from a third to half the weight of the falt, and the falt is at the fame time very foluble, on heating the cryftals of the falt, their water is increafed in temperature, diffolves them, and exhibits a very thick faline liquor. This fufion is in fact nothing but a hot folution: accordingly, when the falt that undergoes it is fuffered to cool, it returns to the folid and even cryftallized ftate. Likewife if we continue to heat a falt thus fufed, its folvent, or water of cryftallization becomes its water of folution, is volatilized, quits it, and the falt dries. This effect has been feen in the fulphates of foda and magnefia, the triple fulphate of alumine, &c. If the action of the fire be carried fo far as to evaporate all the water

of

of cryftallization by continuing to heat the falt after its aqueous fufion, and if it be dried, we are then faid to calcine it.   Formerly this was called burning a falt; and fuch was the meaning of *burned alum*.   Thus the effect of the aqueous fufion is a true folution in boiling water.

25. By the term igneous fufion we indicate that which falts experience independently of their water of cryftallization, whether it occur after the aqueous fufion, and fucceed to it, or whether it be effected without this fufion previoufly taking place.   The firft cafe completely afcertains the difference that exifts between the two fufions.   The fecond exifts when on keeping the falt in a ftate of fufion we perceive it does not dry, but remains conftantly fluid.   It is fuppofed, that falts fufceptible of this igneous fufion, without the aqueous fufion preceding it, contain but little water of cryftallization, or are much more tenacious of what they contain than the former.   It is obvious, that not being fufceptible of lofing it, or of being dried, we cannot fay of them, that they are calcinable.   There are faline fuftances of this kind fo fufible, that they are even capable of ferving as fluxes.   The phofphates and borates particularly belong to this clafs.   Others are very difficult to fufe; and though fome are fo to fuch a degree that they were formerly believed to be infufible, we are at prefent perfuaded that there is no falt endued with perfect infufibility,

infufibility, or the fufion of which we cannot accomplifh by means of a fufficient fire.

26. I rank decrepitation among the phenomena of which falts are fufceptible from the action of fire, becaufe there is in fact a pretty great number in which it takes place. The name it bears is derived from the noife made by the falt when expofed to a fudden heat, either by throwing it on burning coals, or by heating it ftrongly and rapidly in a crucible. This noife is owing to the difperfion of the faline molecules, and the manner of their ftriking the air with which they are thrown: the fplintery breaking of the falt is occafioned by the rapid volatilization of the water, not fufficient in quantity to produce fufion, which flies off in the ftate of vapour, and is fuddenly made to occupy a fpace much more confiderable than that which is filled before between the faline molecule, among which it was concealed. It is evident, that a falt after decrepitation, or being deprived of its water of cryftallization, is precifely in the fame ftate as one that has been dried after aqueous fufion. This phenomenon is very ftrikingly exhibited by the fulphates of barites, lime, ftrontian, and pot-afh, the nitrates of barite and ftrontian, and the muriates of pot-afh, foda, &c.

27. The fimple volatilization of a falt, without its experiencing any intrinfic change, fuppofes an attraction between its component parts too ftrong to be overcome by caloric; and at the

the fame time a tendency to combine with it, which enables them to affume the gafeous form without feparating from one another. There are very few faline fubftances which poffefs thefe two properties; and though it might be truly faid, that fcarcely any one is exempt from volatilization at a very high temperature, there are but very few capable of rifing in the ftate of vapour, and at the fame time preferving the exact proportion and complete adherence of their conftituent parts. The muriate and car-bonate of ammonia are thofe to which this fimple volatility, accompanied with their pre-fervation and integrity in the moft ftriking de-gree, is commonly attributed. Yet feveral chemifts have remarked, that, on fubliming either of them, an ammoniacal fmell exhaled, which appeared to indicate a partial decom-pofition of thefe two ammoniacal falts.

28. It is in fact much more common for the action of fire on volatile faline fubftances, and more particularly on the ammoniacal falts, fince it is among thefe we find the moft volatile, and perhaps, the only ones that are completely fo, not to confine itfelf to their fimple fublimation, or at leaft at the moment when it effects this, it begins to diminifh the attraction of their prin-ciples, and occafion their difunion. This takes place when the ammonia is united to an acid more fixed and lefs decompofable than itfelf, and then the falt fublimed is found to have an excefs of acid, or to be truly acidulous. Thus

it

it is with the ammoniacal fulphate in particular; and perhaps the muriate of ammonia itfelf is nearly to be claffed with it, as it appears to undergo an alteration fomewhat analogous from the action of fire.

29. Many falts experience a decompofition more or lefs complete from the action of caloric accumulated in greater or fmaller quantity. On comparing every thing that occurs in this fpecies of action to all the faline fubftances, we know, we find four kinds of very diftinct decompofition, to which the effects produced on thefe matters by fire, may be referred.

a. Sometimes the acid flies off, and quits the faline compound, fo as to be capable of being collected in a receiver, and to leave the bafe uncombined. For this it is requifite, that the acid on the one hand be volatile, and not decompofable by heat; and befides, that its attraction for the bafe be fufficiently weak to yield to the action of fire. Thus it is with the fulphate, muriate, and carbonate of zircone, the muriates of magnefia, zircone, and alumine, the carbonates of lime, magnefia, glucine, zircone, and even thofe of lime and foda.

b. Some falts are decompofed by fire, in a mode the reverfe of the preceding. It is the bafe which is difengaged from the acids, becaufe it is volatile, and adheres feebly to them. To this kind of decompofition, we muft refer what takes place with fuch of the ammoniacal falts as part with their ammonia, and leave their acid

bare

bare when expofed to a high temperature. Such, among others, are the phofphate and the borate of ammonia. This it is obvious, goes further than partial difengagement, and the formation of an acidule.

c. There are falts fufceptible of a more thorough alteration by the action of fire, becaufe their acid is capable of being decompofed by it, and reduced wholly, or in part to its elements. Such are all the nitrates, fuper-oxigenated muriates, fulphites, and phofphites. The firft, more or lefs ftrongly heated, give out, as already has been feen, oxigen gas and azote gas, and are thus reduced to their pure bafes. The fecond lofe their oxigen, and again become muriates. Thofe of the third and fourth kinds lofe the fulphur or phofphorus which they contain in excefs, and thus return to the ftate of fulphates or phofphates.

d. Laftly, there are fome which are ftill more intimately and completely altered by the action of caloric than the preceding, both their acid and their bafe being reciprocally decompofed at the fame time. Thefe are, in fact, much more rare, for we know fcarcely any one of this kind, except the ammoniacal nitrate : but there is reafon to believe, that by ftudying more carefully the different faline fubftances hitherto little known, feveral fpecies will fome day be found to belong to this order of igneous alteration.

SECTION IV.

Of the Action of Air on Salts.

30. ALL cryſtallized ſalts expoſed to the air are not altered in the ſame manner. There are ſome which experience no perceptible change : but ſeveral, more or leſs readily, loſe their tranſparency and figure ; and of theſe, ſome gradually diſſolve with an addition of weight, others loſe a portion of their ſubſtance and become pulverulent. The firſt of theſe alterations has received the name of deliqueſcence ; the ſecond, that of effloreſcence.

31. One of theſe phenomena has been called deliqueſcence, becauſe the ſaline ſubſtance that exhibits it, becomes liquid. It was alſo ſaid formerly, that a ſalt deliqueſced, or melted *per deliquium,* when it was thus diſſolved by the contact of air. The word *defaillance* (fainting) was thus ſynonimous with deliqueſcence : but this expreſſion has grown obſolete, and it is ſcarcely ever found, at preſent, in chemical books. This alteration is produced by the ſalt's attracting the humidity contained in the air, and I have thought proper to conſider it as the effect of a true elective attraction, which is ſtronger between the ſalt and the water, than between the water and the air of the atmoſphere. Deliqueſcence is not the ſame in all ſalts, either with reſpect to the rapidity of its taking place,

or

or the degree of faturation to which it is limited. There are fome, as the nitrates and muriates of lime and magnefia, which attract the water from the air, and dry it as we may fay, with very confiderable energy, by abforbing a quantity of that fluid greater than their own weight. Some others alfo are very deliquefcent, but do not attract the humidity of the air with equal promptnefs in fo large a quantity : and laftly, there are others, which only acquire a perceptible moifture, and do not completely diffolve, as the nitrate of foda, muriate of potafh, ammoniacal fulphate, &c.

32. Efflorefcence has been fo called, becaufe the falts fufceptible of it, appear to become covered with little white filaments, fimilar to the fublimed fubftances, known in chemiftry by the name of *flowers*. This property is the reverfe of deliquefcence : in the latter, the faline cryftals decompofe the humid atmofphere, becaufe they have a ftronger elective attraction than the air of the atmofphere has for water : in efflorefcence, on the contrary, it is the atmofphere that decompofes the faline cryftals, becaufe the air has a greater affinity for water than the falts that form the cryftals. It is their water of cryftallization, therefore, which is taken from them by efflorefcence ; and this is the reafon why falts when they efflorefce lofe their tranfparency, their figure, and part of their mafs. It is effential to obferve, that all efflorefcent faline cryftals undergo an alteration from the action of

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the

the air, fimilar to what is produced in them by heat : it is a fort of flow and cold calcination that decompofes the cryftallized falts, and feparates from them the water, to which they owed their cryftalline forms, as well as all the properties that diftinguifhed them as *faline cryftals.* Accordingly, a falt completely efflorefced, experiences precifely the fame lofs of weight in this procefs, as when it is dried by the action of fire. It is to be remarked alfo, that the efflorefcent falts belong to the clafs of the moft foluble, and of thofe which cryftallize by the refrigeration of their folutions.

33. As with deliquefcence, fo with efflorefcence, it is not the fame with refpect to all the neutral falts in which it is obferved. There are fome, as the fulphate and carbonate of foda, which efflorefce fpeedily, and to the very laft cryftalline particle, fo that they are reduced to a very fine white powder. As thefe have loft more than half their weight by this decompofition of their cryftals, we may thence conclude, that it is from the great quantity of water entering into their cryftallization, they experience an efflorefcence fo complete : and in fact, the falts which efflorefce but very little, as borax, alum, and fulphate of magnefia, do not contain fo large a quantity of this fluid in their cryftals. If the efflorefcence depend on a ftronger elective attraction between the air and the water, than between the water and the falt, this phenomenon will take place in a more fpeedy and

striking

striking manner when the atmofphere is very dry : and this agrees precifely with obfervation, while air loaded with moifture has not the fame action on the efflorefcent falts, but leaves them unattacked.   This affertion may be further confirmed by pouring a fmall quantity of water on faline cryftals fufceptible of efflorefcence : for this being done, the atmofphere takes up this water, and faturating itfelf with it does not attract that which enters into the conftitution of the cryftals, and thefe remain unaltered : but if we do not take care to renew the water, the air will then act on the cryftallized falt, and deftroy its cryftallization.   This phenomenon is daily obferved in pharmacy, and the venders of drugs take care to moiften the cryftals of fulphate of foda with a fmall quantity of water, in order to preferve their beauty and integrity.

Section V.

Of the Solubility of Salts or their Relation to Water.

34. THE folution of falts in water, or the manner in which thefe bodies diffolve in this liquid, the relative quantity they require to diffolve them, and the phenomena which take place during their folution, deferve the moft ferious attention of chemifts, and this has been paid them ;

for

for they are among the things that have been most ftudied, and obferved with the greateft care and accuracy in our laboratories. As it is effected, that is to fay, as falts diffolve and become liquid without movement, without agitation, and without bubbles; while there are many bodies, which, while they fhare the liquidity of acids, &c. excite much movement, and occafion the extrication of many bubbles of elaftic fluids in what is called effervefcence; fome chemifts have propofed to make a diftinction between thefe two diffolutions, and to call the firft, that of faline fubftances, which is in fact, only a feparation of the molecules effected by water, *folution*, the other *diffolution*. But the difference between thefe two expreffions, which is little perceptible, has not been admitted by the majority of chemifts. It is important, however, to obferve here, that the difference between the two phenomena confifts in this, that a falt diffolving in water does not change its nature any more than the water itfelf, but when a metal is diffolved in an acid, the nature of both thefe fubftances is changed before they unite.

35. Though there is no real change of nature between the falts, and the water that unite in diffolution, this effect muft not be confidered as a phenomenon fimply phyfical, as a mere mechanical divifion of parts. There is an intimate penetration of the molecules; their relations of diftance and attraction are at once modified;

modified; they lofe or abforb caloric; moft fre-
quently this principle is evolved, and the den-
fity of the fubftances augments, or becomes
greater than the mean that fhould refult from
the two known denfities. There is befides a
chemical attraction between the molecules of
the falt, and the molecules of the water:
fince they can be feparated only by chemical
means; fince a ftronger attraction of fome other
body for water as alcohol, &c. feparates them;
and fince all the modifications of adhefion,
which can take place between the faline parti-
cles, and the particles of water, are the caufes
of many other modifications in the forms which
the falts are capable of affuming; for this is
frequently the fource of the varieties of figure
obferved in faline cryftals, owing to varied
decrements on the edges and at the angles, and
to an arrangement of their molecules manifeftly
dependent on attraction.

36. It has been feen in the detailed account
of the fpecies of falts, that each poffeffes a de-
terminate degree of folubility; that is to fay,
each requires a different quantity of water for
its liquefaction or folution. It has been feen
likewife, that this degree of folubility varies ac-
cording to the temperature of the water, aug-
menting in general with its increafe. This pro-
portion between the falt and the water has
already been determined for a pretty confidera-
ble number of faline fubftances: but the tafk
is far from being completed, and we may affirm,

that

that the folubility of one third of the falts fabricated in our laboratories is not yet accurately known. The nature of the inquiries for obtaining this knowledge is fimple, and fufficiently eafy; yet, there are a number of folubilities which have been eftimated imperfectly, or not at all. In the purfuit of this tafk, it will not be lefs important to determine the change of temperature, or difengagement of caloric, which takes place in every folution, as well as the fpecific gravity imparted to the water by different quantities of the fame falt. Tables of thefe different ftates fhould be made out, which would be of great utility both to the chemift and to the manufacturer.

37. On comparing the principal degrees of folubility known in falts, it may be remarked, that fome not diffolving in feveral thoufand times their weight of water, are commonly confidered as *infoluble*: that others, requiring feveral hundred times their weight of water, are called *difficult* to diffolve, or *fparingly foluble*; that many diffolving in twenty, thirty, or forty times their weight, are termed *moderately foluble*; that a pretty confiderable number, demanding only from four to fix times their weight of water, are *very foluble*; and *the moft* foluble will diffolve in an equal weight, or lefs, or even in half their weight of water. All thefe denominations, and the phenomena they reprefent, apply in general to water at the mean temperature of our climates;

climates; that is to fay 12,5 degrees of the centigrade thermometer.

38. For falts that are more foluble in hot water than in cold the fame general feries of folubility, varying in proportion to the heat of the water, may be adopted. There are fome in which the difference is fcarcely perceptible: there are others in which it increafes in a very rapid ratio; in which it is double, for inftance: and laftly, there are fome which are incomparably more foluble in hot water than in cold, fo that the proportion between the extreme of their folubility in hot water, and their folubility in cold, is as fix to one. There can be no doubt, that experiments made with precifion on a great number of thefe differences, which are not known, would be of real utility to the fcience, and lead us to truths, of which we can yet form no fufpicion.

ARTICLE XIV.

A Table of Salts arranged according to their Affinities, and diftinguifhed by fpecific Characters.

1. However methodical I have endeavoured to render the hiftory of falts, the clue that has guided me in their claffification and arrangement may have been loft amid the long details

of

of which that hiftory confifts. To render this method more diftinct and ftriking, which I confider as the only mode of ftudying in future, and of retaining in memory the properties of faline fubftances, fo numerous at prefent, and which will become ftill more fo, I think it neceffary to retrace their fyftematical arrangement on a fmaller fcale, and to annex to each particular fpecies fome of the properties, which may ferve to diftinguifh it from all others. It is an attempt at the method and defcriptions of Linné, applied to one of the parts of chemiftry which appears in truth moft fufceptible of it, and to which it is at the fame time moft neceffary.

2. It muft be remarked, in order to form a juft conception of the following details, that I have taken, as generic characters only, one or two of the moft ftriking and diftinct properties; that this property, or thefe properties, recurring in all the fpecies of the genus, it muft not be forgotten, that they may become fpecific or diftinguifhing characters, with regard to the fpecies of another genus; that thofe which find a place in the defcription of each fpecies, ferve only in ftrictnefs to diftinguifh the fpecies of the genus from each other, the preliminary idea of the generic character being always underftood; that it is on this account the fpecies which correfpond from the identity of their bafes in the different genera, have analogous characters, taken from the properties of thefe bafes, which,

in

in fuch cafes, cannot diftinguifh thefe fpecies
from each other, but by the help of their generic
characters. It is very rare for a fpecies to ex-
hibit a chemical property, which belongs exclu-
fively to itfelf.

3. On this occafion, I fhall obferve, that the
Linnean method of defcription, fo ufeful to the
ftudy of natural hiftory, by its precifion, clear-
nefs, and the ftriking and *decided characters* it
exhibits, when well executed, is of fuch impor-
tance in its application to chemiftry, that this
fcience muft expect from it, a very defirable
improvement in its ftudy. Some modern au-
thors have already attempted this Linnean lan-
guage, and its laconic ftyle of defcription, in
anatomy : but no chemift has yet made a fimilar
effay, either in the theoretical or practical de-
partment of chemical fcience. What I am
going to offer here, may give an idea of the ad-
vantages which we may reafonably expect from
this mode of defcribing the properties, that
depend on the nature and intimate attractions
of the principles of bodies.

Genus I,

Sulphates.

Generic characters. Affording fulphurets,
when heated red-hot with charcoal; copioufly
precipitable by the folution of barites.

4 Species

SPECIES I.

Sulphate of Barites.

Specific Characters. Very heavy, infipid, infoluble; frequent in the native ftate; in-decompofable by the acids and by the fimple alkalis; the moft permanent of falts; poi-fonous.

SPECIES II.

Sulphate of Pot-afh.

Specific Characters. Bitter, foluble, afford-ing nitrate of pot-afh with nitric acid, and fulphate of lime with the calcareous nitrate and muriate; purgative; refembling porcelain after its fufion.

SPECIES III.

Acid Sulphate of Pot-Afh.

Specific Characters. Sour, very fufible, part-ing with its acid on expofure to a ftrong fire.

SPECIES IV.

Sulphate of Soda.

Specific Characters. A cool and bitter tafte; efflorefcing in the air; not precipitable either by ammonia or lime; an attenuant purgative.

SPECIES V.

Sulphate of Strontian.

Specific Characters. Heavy, infipid, infoluble; frequently foffile with fulphate of barites; differing from the latter by the purple colour it imparts to flame before the blow-pipe, by being decompofable by the fixed alkalis, and by not being poifonous.

SPECIES VI.

Sulphate of Lime.

Specific Characters. Infipid; frequent in the earth, and in waters, which it renders hard; well cryftallized by nature; little foluble; precipitable by the oxalic acid and by barites; forming plafter by calcination.

SPECIES

SPECIES VII.

Sulphate of Ammoniac.

Specific Characters. Acrid, bitter, cryftal-
lizable, volatile; rendered acidulous by fire;
giving out ammonia with lime.

SPECIES VIII.

Sulphate of Magnefia.

Specific Characters. Very bitter, very cryf-
tallizable; precipitable by lime, partly fo by
ammonia, and not at all by the carbonates of
pot-afh and ammonia; purgative.

SPECIES IX.

Ammoniaco-Magnefian Sulphate.

Specific Characters. Lefs foluble than
the two preceding fpecies; cryftallizing more
quickly; yielding by means of the fixed al-
kalis, a magnefian precipitate and volatilized
ammonia.

Species X.

Sulphate of Glucine.

Specific Characters. Sweetish and faccharine; precipitable by barites, and by all the alkalis, an excefs of which re-diffolves the precipitate; the precipitate very foluble in carbonate of ammonia.

Species XI.

Sulphate of Alumine, Saturated or Acid.

Specific Characters. Styptic to the tafte; not cryftallizable, forming a jelly; precipitable by potafh and foda, an excefs of which re-diffolves the earth.

Species XII.

Acid Sulphate of Alumine and Pot-afh.

Specific Characters. Styptic to the tafte; of an octahedral figure; yielding pyrophorus when calcined with vegetable matter; aftringent.

Species

SPECIES XIII.

Saturated triple Sulphate of Alumine.

Specific Characters. Infoluble, infipid, earthy, or cryftallized in cubes; exhibiting traces of pot-afh and ammonia like the preceding, but not yielding pyrophorus.

SPECIES XIV.

Sulphate of Zircone.

Specific Characters. Pulverulent, or in fmall needles; friable, infipid, decompofable by the heat of boiling water which precipitates its bafe; infoluble except by the aid of the fulphuric acid.

GENUS II.

Sulphites.

Generic Characters. Yielding fulphur, and becoming fulphates in the fire; exhaling the fmell of fulphur with efflorefcence and fparkling, burning by the contact of fulphuric, nitric, muriatic acids, &c.; changing into fulphates

phates by long expofure to the air when they are dry, and very quickly when in a ftate of folution.

SPECIES XV.

Sulphite of Barites.

Specific Characters. Pulverulent, needled or tetrahedral; very heavy; little fapid; infoluble, except in an excefs of fulphureous acid.

SPECIES XVI.

Sulphite of Lime.

Specific Characters. Pulverulent, or in hexa‑hedral prifms with pyramids of fix very long faces; little fapid; permanent a long time in the air in its dry form; little foluble, lefs fo than the fulphate of lime.

SPECIES XVII.

Sulphite of Pot‑afh.

Specific Characters. In radiated needles or rhomboidal laminæ; of a pungent fulphureous

tafte; decrepitating in the fire; efflorefcent; its folution fpeedily abforbing oxigen gas, and forming a pellicle of fulphate in the air; very foluble; decompofing the foluble fulphates.

SPECIES XVIII.

Sulphite of Soda.

Specific Characters. Prifms of four fides, with dihedral fummits; a cool, fulphureous tafte; fufion aqueous; efflorefcent or foluble; cryftallizing by refrigeration; the moft loaded with water of cryftallization.

SPECIES XIX.

Sulphite of Strontian.

Specific Characters. Unknown.

SPECIES XX.

Sulphite of Ammonia.

Specific Characters. Prifmatic; a cool and pungent tafte; becoming acid by fublimation; delique-

deliquefcent; the moft fpeedily changed into
fulphate by the air.

SPECIES XXI.

Sulphite of Magnefia.

Specific Characters. In the form of flat-
tened tetrahedra; foftening into a mucilage in
the fire; fwelling up much in calcination, lofe-
ing by the action of fire the whole of its ful-
phureous acid, and leaving the magnefia pure.

SPECIES XXII.

Ammoniaco-magnefian Sulphite.

Specific Characters. Cryftallizable; yielding
by fire acid fulphite of ammonia fublimed, and
fulphureous acid, and leaving the magnefia
calcined.

SPECIES XXIII.

Sulphite of Glucine.

Specific Characters. Unknown.

SPECIES

SPECIES XXIV.

Sulphite of Alumine.

Specific Characters. A white greafy powder; crackling with water; little foluble even in an excefs of its acid; its acid folution however yielding in the air a tenacious and ductile pellicle of fulphate.

SPECIES XXV.

Sulphite of Zircone.

Specific Characters. Unknown.

6. GENUS III.

Nitrates.

Generic Characters. Yielding impure oxigen gas mingled with azote by the action of fire, which reduces them to their bafes; giving out a white vapour with concentrated fulphuric acid; inflaming all combuftible fubftances in a red heat.

SPECIES

Species XXVI.

Nitrate of Barites.

Specific Characters. Cryſtallizable in octahedra; very ſoluble; the only ſubſtance that yields pure barites by ſtrong calcination; the only nitrate that precipitates abundantly and forms an inſoluble ſediment with ſulphuric acid; poiſonous.

Species XXVII.

Nitrate of Pot-aſh.

Specific Characters. Priſmatic; of a cool taſte; unalterable in the air; very fuſible; cooling greatly with water; yielding a ſaline and cryſtallized precipitate with oxalic acid.

Species XXVIII.

Nitrate of Soda.

Specific Characters. Rhomboidal; a little deliqueſcent in the air; yielding no cryſtallized precipitate with oxalic acid.

SPECIES XXIX.

Nitrate of Strontian.

Specific Characters. Cryftallizing like the nitrate of barites ; yielding its bafe very pure by calcination ; reddening the flame of the blow-pipe, of a wax candle, of alcohol ; precipitable by fixed alkalis ; not poifonous.

SPECIES XXX.

Nitrate of Lime.

Specific Characters. Very deliquefcent ; very acid ; precipitable by the fulphuric and oxalic acids ; decompofing the fulphates of pot-afh, foda, and ammonia.

SPECIES XXXI.

Nitrate of Ammonia.

Specific Characters. Acid, bitter, brilliant, fatin-like, deliquefcent ; inflaming alone in clofe veffels, and yielding water as a product with a portion of nitric acid not decompofed.

SPECIES

Species XXXII.

Nitrate of Magnesia.

Specific Characters. Cryftallizing difficultly; yielding no precipitate with faturated carbonate of pot-afh; fubfiding fpeedily in triple cryftals from its folution on the addition of that of nitrate of ammonia.

Species XXXIII.

Ammoniaco-magnefian Nitrate.

Specific Characters. Very cryftallizable; precipitating its magnefia by fixed alkali, and at the fame time giving out ammonia.

Species XXXIV.

Nitrate of Glucine.

Specific Characters. Of a fweetifh and faccharine tafte, mixed with a little roughnefs; precipitable by all the bafes, except alumine and zircone; forming with ammonia a precipitate which carbonate of ammonia re-diffolves.

SPECIES

SPECIES XXXV.

Nitrate of Alumine.

Specific Characters. Not cryftallizable; of a ftyptic tafte; in form of jelly; yielding by ammonia a precipitate which the fixed alkalis re-diffolve.

SPECIES XXXVI.

Nitrate of Zircone.

Specific Characters. Unknown.

7. GENUS IV.

Nitrites.

Generic Characters. Obtained by heating and half decompofing nitrates by fire; diffufing an orange-coloured vapour of nitrous acid when acted on by fulphuric acid, or even by nitric acid.

SPECIES

37. *Nitrite of barites.*
38. *Nitrite of pot-ash.*
39. *Nitrite of soda.*
40. *Nitrite of strontian.*
41. *Nitrite of lime.*
42. *Nitrite of Ammonia.*
43. *Nitrite of magnesia.*
44. *Ammoniaco-magnesian nitrite.*
45. *Nitrite of glucine.*
46. *Nitrite of alumine.*
47. *Nitrite of zircone.*

Too little known yet as species for me to attempt to give their specific characters: but it is obvious, that, to determine the particular species, when once the genus is known, the simple action of fire, which will leave the base disengaged and pure, is sufficient for this investigation.

8. GENUS V.

Muriates.

Generic Characters. Yielding, when acted on by concentrated sulphuric acid, a white vapour of muriatic acid, which is disengaged with crackling and effervescence; yielding, when acted on by nitric acid, oxigenated muriatic acid gas; the most volatile and least decompofable by fire of all the salts.

SPECIES

SPECIES XLVIII.

Muriate of Barites.

Specific Characters. Yielding large and fine bevelled cryftalline tablets; diffufing a thick vapour, and at the fame time forming a heavy and copious precipitate when acted on by fulphuric acid; extremely attenuant and poifonous.

SPECIES XLIX.

Muriate of Pot-Afh.

Specific Characters. Of a cubic figure; of a bitter and falt tafte; forming a cryftalline precipitate with oxalic acid; purgative and febrifuge.

SPECIES L.

Muriate of Soda.

Specific Characters. Of a cubic figure; of an agreeable falt tafte, being the only one that affords it among the numerous tribe of falts; decrepitating in the fire; affording no precipitated

pitated cryftals with oxalic acid; the natural feafoning of food both to man and to feveral animals.

SPECIES LI.

Muriate of Strontian.

Specific Characters. In figure fimilar to the muriate of barites; differing from it by being precipitable by alkalis, by the purple colour it imparts to flame, and by not being poifonous.

SPECIES LII.

Muriate of Lime.

Specific Characters. Cryftallizable in a mafs, with much heat; very deliquefcent, very acrid; producing much cold with ice; precipitated abundantly by the fulphuric and oxalic acids; decompofing the fulphates of pot-afh and foda by neceffary double attractions; very atte= nuant, very purgative.

SPECIES LIII.

Muriate of Ammonia.

Specific Characters. Volatile, fublimable; giving out ammonia in vapour with barites, ftrontian, lime, pot-afh, and foda; producing much cold with water; tonic, attenuant, ftimulant, febrifuge.

SPECIES LIV.

Muriate of Magnefia.

Specific Characters. Cryftallizing difficultly; not precipitable by the faturated alkaline carbonates without heat; yielding with ammonia a precipitate infoluble in the cauftic alkalis.

SPECIES LV.

Ammoniaco-Magnefian Muriate.

Specific Characters. Very cryftallizable; yielding at the fame time a precipitate infoluble by the fixed alkalies, and a very ftrong ammoniacal vapour.

SPECIES

SPECIES LVI.

Muriate of Glucine.

Specific Characters. Of a fweet, faccharine, flightly-aftringent tafte; affording with the alkalis a precipitate, foluble in carbonate of ammonia, and re-appearing when acted on by heat.

SPECIES LVII.

Muriate of Alumine.

Specific Characters. Not cryftallizable; gelatinous; of an auftere tafte; decompofable by a ftrong fire; forming a precipitate, very foluble in an excefs of fixed alkali.

SPECIES LVIII.

Muriate of Zircone.

Specific Characters. Of a needled form; of an auftere tafte; eafily yielding its acid by heat; deliquefcent; very foluble; precipitating with the fulphuric and phofphoric acids in fulphate or phofphate of zircone.

SPECIES

Species LIX.

Muriate of Silex.

Specific Characters. Permanent only in the liquid form, and in a cold temperature; decompofable by heat, which precipitates the filex in a white powder; frequently affuming the form of jelly by cold.

9. Genus VI.

9. *Super-oxigenated Muriates.*

Generic Characters. Yielding very pure oxigen gas by the action of fire and returning 'to the ftate of muriates; the ftrong acids expel their fuper-oxigenated muriatic acid, with noife or explofion; inflaming combuftible fubftances even fpontaneoufly and with fulguration.

Species LX.

Super-oxigenated Muriate of Barites.

Specific Characters. Unknown.

Species LXI.

Super-oxigenated Muriate of Pot-Ash.

Specific Characters. In figure an obtufe rhomboid ; very tranfparent ; very brittle ; fparkling and phofphorefcent by friction ; ftrongly inflaming lighted charcoal on which it is placed ; leaving muriate of pot-afh after being acted on by fire.

Species LXII.

Super-oxigenated Muriate of Soda.

Specific Characters. Prifmatic ; inflaming charcoal lefs than the preceding ; lefs fixed ; leaving after calcination pure muriate of foda.

Species LXIII.

Super-oxigenated Muriate of Strontian.

Specific Characters. Unknown

SPECIES LXIV.

Super-oxigenated Muriate of Lime.

Specific Characters. Sweetifh ftyptic ; little durable.

SPECIES LXV.

Super-oxigenated Muriate of Magnefia.

Specific Characters. Unknown.

SPECIES LXVI.

Super-oxigenated Muriate of Glucine.

Specific Characters. Unknown.

SPECIES LXVII.

Super-oxigenated Muriate of Alumine.

Specific Characters. Unknown.

SPECIES

Species LXVIII.

Super-oxigenated Muriate of Zircone.

Specific Charaƈters. Unknown

10. Genus VII.

Phofphates.

Generic Charaƈters. Not yielding phofphorus when heated with charcoal; fufible into opaque or tranfparent glaffes; phofphorefcent at a high temperaturate; foluble in nitric acid without effervefcence; precipitable from this folution by lime-water.

Species LXIX.

Phofphate of Barites.

Specific Charaƈters. Little foluble; pulveru-lent; infipid.

SPECIES LXX.

Phosphate of Lime.

Specific Characters. Infoluble, infipid; forming a fort of porcelain with a ftrong fire; exifting native in the ftony, cryftalline, and gem form; foluble in phofphoric acid; converted into the ftate of an acidule by the other acids.

SPECIES LXXI.

Acidulous Phofphate of Lime.

Specific Characters. Of a four tafte; in the form of pearly fcales; foluble; not decompofable by the acids.

SPECIES LXXII.

Phofphate of Strontian.

Specific Characters. Infoluble; reddening the flame of the blow-pipe; decompofable by lime and barites.

Species LXXIII.

Phosphate of Pot-Ash.

Specific Characters. Not cryftallizable; deliquefcent; affording with lime-water a precipitate foluble in the acids without effervefcence.

Species LXXIV.

Phosphate of Soda.

Specific Characters. Very cryftallizable; efflorefcent; very fufible by the blow-pipe; affording an opaque glafs by refrigeration; giv- the fame precipitate with lime-water as the preceding; eafily taking an excefs of foda; purgative.

Species LXXV.

Phosphate of Ammonia.

Specific Characters. Cryftallizable; decompofable by fire, which fufes it into an acid and tranfparent glafs; affording phofphorus with charcoal.

SPECIES LXXVI.

Phosphate of Soda and Ammonia.

Specific Characters. Exifting in the animal fluids; very cryftallizable; affording with lime an infoluble precipitate, and at the fame time an ammoniacal vapour.

SPECIES LXXVII.

Phosphate of Magnesia.

Specific Characters. Cryftallizable; of a fweet-ifh tafte; little foluble; uniting with ammonia into a fpecies of triple falt, though well neutralized and faturated; exifting in human urine.

SPECIES LXXVIII.

Ammoniaco-magnesian Phosphate.

Specific Characters. Little foluble; little fapid; frequently depofited in white fparry ftrata in human urinary calculi; giving out an ammoniacal vapour and magnefia when in contact with cauftic alkalis.

Species LXXIX.

Phosphate of Glucine.

Specific Characters. Sweetish; yielding with lime a precipitate soluble in carbonate of ammonia.

Species LXXX.

Phosphate of Alumine.

Specific Characters. Thick, gelatinous; yielding with all the bases a precipitate re-dissolvable by caustic alkalis.

Species LXXXI.

Phosphate of Zircone.

Specific Characters. Unknown.

SPECIES

Species. LXXXII.

Phosphate of Silex.

Specific Characters. Vitreous; infipid, infoluble, permanent, refembling a gem; not foluble in acids till it has been fufed in four times its weight of alkali.

11. Genus VIII.

Phosphites.

Generic Characters. Yielding a phofphorefcent flame when heated; giving out a little phofphorus in a ftrong fire, and thus returning to the ftate of phofphates, but in lefs quantity than before.

Species LXXXIII.

Phosphite of Lime.

Specific Characters. In powder when very neutral, needled when acid; not decompofable by any bafe.

Species LXXXIV.

Phofphite of Barites.

Specific Characters. An infipid powder; very luminous with the blow-pipe; an acidule more foluble than that of lime; its folution rendered turbid by lime-water.

Species LXXXV.

Phofphite of Strontian.

Specific Characters. Unknown.

Species LXXXVI.

Phofphite of Magnefia.

Specific Characters. Infipid; flocculent, or in very fmall tetrahedra; efflorefcent; little foluble.

Species

Species LXXXVII.

Phosphite of Pot-ash.

Specific Characters. A rectangular four-sided prism, with a dihedral summit; of a pungent and salt taste; very little luminous with the blow-pipe; little deliquescent; very soluble, most with heat; precipitable by the solutions of lime, barites, and strontian.

Species LXXXVIII.

Phosphite of Soda.

Specific Characters. A four-sided prism with a pyramid of four faces; slightly efflorescent; not more soluble by heat.

Species LXXXIX.

Phosphite of Ammonia.

Specific Characters. Yielding with the blow-pipe strong sparks and phosphoric flames with a ring of white vapour; affording by distillation phosphoreous hidrogen gas.

SPECIES

SPECIES XC.

Ammoniaco-Magnesian Phosphate.

Specific Characters. Uniting with a feebler degree of the property of the preceding, that of affording sulphate of magnesia with sulphuric acid.

SPECIES XCI.

Phosphite of Alumine.

Specific Characters. Styptic, of a gummy confistence; swells and puffs up in the fire.

SPECIES XCII.

Phosphite of Glucine.

Specific Characters. Unknown.

SPECIES XCIII.

Phosphite of Zircone.

Specific Characters. Unknown.

12. GENUS

12. Genus IX.

Fluates.

Generic Characters. Very weak falts, yielding with concentrated fulphuric acid, a vapour which corrodes glafs, and is precipitated by water.

Species XCIV.

Fluate of Lime.

Specific Characters. Infipid, infoluble, fparry refembling glafs in its native ftate; phofphorefcent; foluble in the nitric and muriatic acids, and forming afterwards an infoluble precipitate with the oxalic.

Species XCV.

Fluate of Barites.

Specific Characters. Very foluble and cryftallizable; precipitated in cryftals by the oxalic acid; precipitable by the fulphuric acid, and by the alkaline carbonates.

2   Species

Species XCVI.

Fluate of Strontian.

Specific Characters. Unknown.

Species XCVII.

Fluate of Magnesia.

Specific Characters. Precipitated in a cloud by ammonia, and not by the faturated alkaline carbonates.

Species XCVIII.

Fluate of Pot-Ash.

Specific Characters. In the form of jelly; very foluble; precipitable by lime-water; yielding a foluble precipitate with oxalic acid.

Species XCIX.

Siliceous Fluate of Pot-Ash.

Specific Characters. Acted on by a ftrong fire leaves filiceous pot-afh.

<div align="right">Species</div>

Species C.

Fluate of Soda.

Specific Characters. Cryſtallizing in cubes; of a ſalt, acrid taſte; precipitable by lime-water, and not by oxalic acid.

Species CI.

Siliceous Fluate of Soda.

Specific Characters. Leaving, on vitrification, ſiliceous ſoda.

Species CII.

Fluate of Ammonia.

Specific Characters. Decompoſable by heat, and even by ſilex; giving out ammonia with all the baſes.

SPECIES

Species CIII.

Ammoniaco-magnesian Fluate.

Specific Characters. With the fixed alkalis precipitating magnesia, and at the same time exhaling an ammoniacal vapour.

Species CIV.

Ammoniaco-siliceous Fluate.

Specific Characters. Affording a precipitate of silex on heating its solution.

Species CV.

Fluate of Glucine.

Specific Characters. Of a mild saccharine taste; the precipitate, formed by alkalis, soluble in carbonate of ammonia.

Species

Species CVI.

Fluate of Alumine.

Specific Characters. Of a gelatinous form; of an auftere tafte; yielding with ammonia a precipitate foluble in the cauftic fixed alkalis.

Species CVII.

Fluate of Zircone.

Specific Characters. Unknown.

Species CVIII.

Fluate of Silex.

Specific Characters. The only cryftallizable filiceous falt; partly decompofable by water, which feparates the filex.

12. Genus X.

Borates.

Generic Characters. All fufible into glafs; their concentrated folutions, on the addition of the

the fulphuric, nitric, and muriatic acids, &c.
afford lamellated, brilliant, and pearly cryftals
of boracic acid.

SPECIES CIX.

Borate of Lime.

Specific Characters, Uncryftallizable, infipid,
infoluble; its folution in acids affording a pre-
cipitate with oxalic acid.

SPECIES CX.

Borate of Barites.

Specific Characters. Soluble, and affording a
copious precipitate with fulphuric acid.

SPECIES CXI.

Borate of Strontian.

Specific Characters. Unknown.

SPECIES CXII.

Borate of Magnesia.

Specific Characters. Infoluble; undecompof-able by the alkalis; yielding with fulphuric acid fulphate of magnefia.

SPECIES CXIII.

Magnefio-calcareous Borate.

Specific Characters. Emitting fparks with the fteel; fcratching glafs; very diftinguifhable in the native ftate by its fub-cubic figure, its bor-ders, its incomplete angles, and its electrical property.

SPECIES CXIV.

Borate of Pot-Afh.

Specific Characters. Affording a cryftalline precipitate with oxalic acid.

SPECIES

SPECIES CXV.

Borate of Soda.

Specific Characters. Yielding no precipitate with oxalic acid; abforbing foda.

SPECIES CXVI.

Super-faturated Borate of Soda.

Specific Characters. Alkaline, turning blue vegetable colours green; abforbing boracic acid.

SPECIES CXVII.

Borate of Ammonia.

Specific Characters. Yielding ammonia by the action of fire, and fufing into an acid glafs.

SPECIES CXVIII.

Ammoniaco-magnefian Borate.

Specific Characters. Yielding ammonia in the

fire without melting, and fulphate of magnefia with fulphuric acid.

SPECIES CXIX.

Borate of Glucine.

Specific Characters. Unknown.

SPECIES CXX.

Borate of Alumine.

Specific Characters. Little foluble ; precipitable by the alkalis.

SPECIES CXXI.

Borate of Zircone.

Specific Characters. Yielding with the blowpipe a yellowifh glafs ; little known.

SPECIES CXXII.

Borate of Silex.

Specific Characters. Vitreous ; infipid ; infoluble ; unalterable in the air.

13. GENUS

13. GENUS XI.

Carbonates.

Generic Characters. All retaining fome flight alkaline properties; with all the acids they produce a brifk and rapid effervefcence, which is not accompanied with a white vapour.

SPECIES CXXIII.

Carbonate of Barites.

Specific Characters. Undecompofable by fire, which cannot feparate its carbonic acid; lofing its acid when calcined with charcoal; poifonous.

SPECIES CXXIV.

Carbonate of Strontian.

Specific Characters. Similar to that of barites with regard to the action of fire; imparting a purple colour to flame; not poifonous.

SPECIES CXXV.

Carbonate of Lime.

Specific Characters. Infipid, foluble by carbonic acid; converted into lime by fire.

M 2 SPECIES

Species CXXVI.

Carbonate of Pot-Ash.

Specific Characters. Very cryftallizable; little alterable in the air; not precipitating the magnefian falts without heat.

Species CXXVII.

Carbonate of Soda.

Specific Characters. Efflorefcent in the air; decompofing the magnefian falts without heat.

Species CXXVIII.

Carbonate of Magnefia.

Specific Characters. Cryftallizing in fix-fided prifms; efflorefcent; decompofable by the alkalis.

SPECIES CXXIX.

Carbonate of Ammonia.

Specific Characters. Volatile, odorant, not decompofable by heat.

SPECIES CXXX.

Ammoniaco-magnefian Carbonate.

Specific Characters. Yielding with cauftic fixed alkalis the ammoniacal fmell, and at the fame time pure magnefia.

SPECIES CXXXI.

Carbonate of Glucine.

Specific Characters. In a clotted and greafy powder; infipid; eafy to be calcined; infoluble even by its own acid; foluble in ammonia, in proportion as this affumes the ftate of a carbonate.

SPECIES

SPECIES CXXXII.

Carbonate of Alumine.

Specific Characters. Lofing in the air, and by fimple deficcation, the greater part of the carbonic acid which it received in the humid way.

SPECIES CXXXIII.

Carbonate of Zircone.

Specific Characters. Pulverulent, infipid, infoluble, except in the alkaline carbonates, all which diffolve it, and feem to form with it triple falts.

SPECIES CXXXIV.

Ammoniaco-zirconian Carbonate.

Specific Characters. More foluble than the carbonate of zircone; its folution being heated evolves ammoniacal carbonate, becomes turbid, and depofits carbonate of zircone; not precipitable by ammonia.

SPECIES

Species CXXXV.

Ammoniaco-glucinian Carbonate.

Specific Characters. More foluble than the carbonate of glucine; letting fall the latter in powder, when its folution is heated in contact with air, and the carbonate of ammonia is diffipated in vapour.

14. In characterizing the hundred and thirty-five very diftinct fpecies of falts, both by their refpective difpofitions, and by fpecific properties equally diftinct and invariable, I have endeavoured to fhow, that their arrangement and claffification into genera and fpecies, after the manner of botanifts and hiftorians, may afford the chemical ftudent a method not lefs eafy and precife, than that which has been eftablifhed in the ftudy of plants and animals. Something, however, would ftill be wanting to this picture if I confined it to the fimple exhibition of the arrangement I have followed in the hiftory of falts, and omitted to annex to it a fketch of another courfe, and the poffibility of treating this fubject fyftematically according to a different order.

5. From all the preceding details has appeared the reafon why I have preferred forming the genera of falts from their acids ; but I have mentioned that it was not impoffible to eftablifh

the

the genera on their bafes, a mode adopted by feveral chemifts. I myfelf, when I began my lectures twenty years ago, recurred to the bafes for diftinguifhing the genera. When I here pre-fent a method, the reverfe of my firft, an enunci-ation of the character of the genera will be fuf-ficient to difplay the advantages of that which I have preferred ; I fhall find in it likewife the means of multiplying the characters of our true faline fpecies, for it is obvious that every genus, here founded on a falifiable bafe, will become an exact reprefentation of the characters that exift in all the fpecies of which the difference is determined by that bafe for the genera efta-blifhed on the acids.

16. If we admit the bafe to determine the genus of a falt, we fhall have ten different ge-nera ; for we cannot make one of filex, which affords only two or three combinations with acids, of little permanence, or very little faline. If we then clafs thefe ten genera, according to the principle already adopted of the affinity of their bafes for acids, proceeding from the ftrongeft to the weakeft, we fhall have,

    1. The genus of falts, with barites for their
        bafe.

    2. That of falts, with pot-afh for their
        bafe.

    3. Salts of foda.

    4. Salts of ftrontian.

    5. Salts of lime, or calcareous falts.

                  6. Ammo-

6. Ammoniacal falts, or thofe with ammo-
nia for their bafe.

7. Magnefian falts, or thofe with magnefia
for their bafe.

8. Salts of glucine.

9. Salts of alumine.

10. Salts of zircone.

Each of thefe genera may be characterized in
the following manner :

17. The falts, with *barites* for their bafe, are
the moft folid, the moft difficult to decompofe;
their tafte, folubility, and figure, vary fo much,
that we cannot derive from thefe any generic
character; all are more or lefs poifonous; almoft
all are undecompofable by fire, if we except
the nitrate, nitrite, fulphite, phofphate, and
fuper-oxigenated muriate, the acids of which
are wholly, or in part decompofed by heat.
They are all decompofed by the carbonates of
pot-afh, foda, and ammonia.

18. The falts, with *pot-afh* for their bafe, are
all fapid and foluble, and almoft all cryftalliza-
ble ; fire melts, calcines, vitrifies, or decom-
pofes them, and reduces them to their bafe.
They are almoft all bitter purgatives, attenu-
ants, and diuretics. Of the bafes, barites is the
only one that decompofes them in general ;
lime decompofes a few, but rarely. Their ele-
ments are frequently feparated by double elec-
tive attractions ; and thefe decompofitions are
obtained chiefly by the help of calcareous falts.

19. The falts, with *foda* for their bafe, have
many

many properties in common with the preceding. On forming a genus of them, we find, as in the laft, that they all have a pungent, bitter, falt tafte, that they cryftallize more or lefs eafily, that they much the moft generally efflorefce in the air, that they have an aqueous fufion, deficcation, and calcination, which precede the igneous fufion, the mere water of cryftallization being the caufe of the two laft properties. A very decided character diftinguifhes them from the falts, with pot-afh for their bafe; like them, they are decompofable by barites, and likewife by pot-afh, which has a ftronger affinity than foda for acids.

20. The falts of *ftrontian* have nothing in common in their figure, tafte, or folubility; fome are infipid and infoluble, others are very foluble and very acrid. They vary equally in the manner in which they are acted upon by air and fire. But, they are all decompofable by barites, pot-afh, and foda; and they are the only falts which are fo by thefe three bafes indifferently.

21. The *calcareous* falts, not being characterizable as a genus by their figure, tafte, or folubility, or by the action of air or fire on them, fince thefe properties vary according to the different acids that are combined in them with lime, are accurately to be diftinguifhed only as being decompofable by barites, pot-afh, foda, and ftrontian. Thefe bafes, when diffolved in water, and poured into folutions of calcareous falts,

con-

constantly produce a precipitation of lime. They are distinguished also by being all decomposed, and precipitated as an insoluble salt by oxalic acid, a species of vegetable acid which has the strongest attraction for lime, and takes it from all other acids.

22. The *ammoniacal* salts have more distinguishing characters dependant on their base, than the greater part of the preceding salts. Almost all have an acrid, pungent, bitter taste, a solubility sufficiently decided, are volatile and sublimable by fire ; those which do not thus become volatile are decomposed, letting their base, their ammonia alone, escape wholly or in part, and thus becoming acidulous salts, or being reduced to their pure acid. Beside this, their base, so distinguishable for its pungent smell, is disengaged without heat by simple contact with barites, pot-ash, soda, strontian, and lime.

23. The *magnesian* salts, not uniform in their physical properties, their figure, specific gravity, &c. have, in general, however, a taste pretty commonly bitter. Barites, pot-ash, soda, strontian, and lime, decompose them completely, and precipitate their earthy base; ammonia decomposes them but in part, and forms, with the remainder, triple salts. A magnesian salt may very certainly be distinguished by this, that its solution, united with the solution of an ammoniacal salt containing the same acid, affords, almost instantly, crystals, pretty quickly deposited, of a triple ammoniaco-magnesian salt.

24. Salts

24. Salts with *glucine* for their bafe, befide being decompofed and precipitated by all the preceding bafes, the combinations of which have been mentioned, have two other characters, ferving to diftinguifh them from every other poffible genus, becaufe, they belong fo exclufively to thefe falts, as to be met with in no other. One of thefe is a fweetifh, and as it were, faccharine tafte, which has occafioned the earthy bafe to receive the name it bears ; the other confifts in the folution by carbonate of ammonia of the earth at firft precipitated by alkalis. The glucine is feparated from this folution by heat, which expels the ammoniacal carbonate, and then permits the glucine, which this falt held diffolved in the water, to precipitate in a pulverulent and earthy form.

25. The falts with *alumine* for their bafe, have all a more or lefs acerb or aftringent tafte, and fometimes even ftrongly ftyptic ; they are very eafily recognized, either by this, that all the alkaline and earthy bafes, zircone excepted, decompofe them, and precipitate their bafe, or, and indeed ftill more particularly, by the alumine, feparated from their folution in a light flocculent form, diffolving with very great facility in the cauftic alkalis.

26. Laftly, the falts with *zircone* for their bafe, are the weakeft and moft decompofable of all. Precipitable by lime, as by all the other alkaline and earthy bafes, they are very readily diftinguifhed from all other falts, and efpecially from

from thofe of alumine, by their earth, when fe-
parated, not being foluble in alkalis added to
it. In thefe, we know alumine readily diffolves ;
and glucine, which diffolves in them alfo, is
the only bafe caufed to difappear by carbonate
of ammonia.

ARTICLE XV.

Of the Action of Salts on each other, and of their reciprocal decompofitions.

1. AMONG the facts depending on the pro-
perties of faline fubftances, there is not one
more interefting to the obferver, exhibiting
more curious phenomena to the chemift, or
affording more important conclufions to artifts
and manufacturers, than the reciprocal action
which they exert on one another. On com-
paring all the data, which fcience has yet allowed
us to collect, refpecting this mutual action,
I find it divides itfelf into fix different pheno-
mena ; and as I have not entered into all the
particulars of thefe phenomena, when giving
the hiftory of the fpecies, which would have
increafed without much advantage, the length
of that hiftory, already of fufficient extent, it
appears to me of fome utility, at leaft, to exhi-
bit a general out-line of them, in a particular
article, with part of the refults to be derived

2   from

from them in their application to the operations
of nature, and the proceffes of art.

2. I fhall firft obferve, that falts fcarcely ever
act on each other, unlefs one, if not both of
them, be diffolved in water, or water be added
to them, when mutually in contact. In this cafe,
which difpofes them to reciprocal action, one or
other of the fix following circumftances is ob-
ferved.

A. The folutions mix without any alteration,
and in fuch a manner, that the falts may be
feparated from one another by evaporation as
pure, and the fame in quantity, as they were
before.

B. Or the two falts unite without any reci-
procal alteration, without changing their nature,
and fo as to form a triple compound, when they
are two fpecies of the fame genus, that is to fay,
when they contain the fame acid, or two fpecies
of a different genus, but having the fame bafe,
which is a lefs frequent occurrence.

C. Sometimes one of the falts, more greedy
of water than the other, takes from it this fol-
vent liquid, and precipitates it from its folution.
In this cafe, fometimes a folution of a falt, which
was not difpofed to cryftallize, depofits cryftals
on the addition of another faline folution : fome-
times, on the contrary, a folution, inftead of
cryftallizing as it would have done, if it had
continued pure and unmixed, affords no cryftals,
and remains a liquid.

4   D. There

D. There are falts, which mutually render each other more or lefs foluble by their mixture in the fame liquid, and which thus, by their fimultaneous contact with water, change the laws of their folubility. Thus, frequently, water faturated with a falt, becomes capable of diffolving a frefh portion of it, if another faline fubftance be previoufly added to it.

E. A great number of falts experience a partial decompofition by contact with each other.

F. Laftly, many are entirely or completely decompofed, when they are made to act on one another.

3. Of thefe fix kinds of action, of which fome ftriking inftances have been adduced in the details given of the different fpecies of falts, but which have yet been far from appreciated in the mutual relations of all the fpecies, becaufe this determination requires an immenfe labour, yet fcarcely begun, I fhall felect the laft in particular, as the moft important object, the moft ufeful to be known, that, on which moft facts have hitherto been collected, in a word, that which is beft calculated to enable us to judge of the ftate of advancement, at which fcience has arrived, and the degree of perfection it will fome day reach. In a courfe of chemical lectures twenty years ago, fcarcely a dozen examples of the mutual decompofitions of falts by each other were adduced, while at prefent, we know near two thoufand, and we have reafon to fufpect a ftill greater number. No part of the

science

science being more advantageous than this for
the knowledge of a number of phenomena, both
of nature and art, I shall exhibit it here suffi-
ciently at large, to supply what may be wanting
in this respect in the preceding articles, dedi-
cated to the particular history of the species.
I shall first point out the general principles
of these mutual saline decompositions : and
afterward give, species by species, a view of
those that are either well known by experience,
or established on well founded presumption.

4. Whenever two salts, different from each
other both in their bases and acids, undergo a
mutual decomposition, a double change of the
bases and acids takes place, and there is always
a double elective attraction. This attraction,
however, is to be considered either as *superfluous*,
or as *necessary* : it is superfluous, when the base
of that salt, which is employed to decompose
the other, has more attraction for the acid of
the latter salt than for its own ; on the contrary,
it is necessary, when, neither the acid nor the
base of the salt used for the decomposition of
another being able to effect it, the simultaneous
action of both is indispensable for the accom-
plishment of the decomposition. Considered
in this point of view, most of the double changes
of acids and bases that take place between salts,
are effected by superfluous attractions, and there
are but few that require the accumulation of ne-
cessary attractive powers to enable them to act.

5. To

5. To judge of the actions, and particularly of the reciprocal decompofitions which falts are capable of exercifing on one another, it is ufual to mix them diffolved in water. This fluid, keeping their refpective molecules in a ftate of feparation, enables them to act upon each other, and produce together, the effect which ought to arife from the attractions of their component parts. Though this effect, in the cafe of double decompofitions, is moft commonly announced by a precipitate, which is more or lefs quickly formed; (as the precipitation takes place only when one of the newly formed falts is much lefs foluble than the other, and than the two that exifted before) there are cafes of decompofition, in which the new falts, being very foluble, do not quit the water. We muft not infer, therefore, when no precipitation takes place, that this decompofition does not exift; but we ought to examine the liquor that remains clear, by fubjecting it to flow evaporation, and extract from it the two falts that exift in the folution, feparating them at the fame time from each other. Water, therefore, acts a part in thefe operations, by the kind of attraction it exercifes either upon the falts mixed together previous to their reciprocal decompofition, or on thofe to which this reciprocal decompofition gives birth; fometimes it promotes or accelerates this decompofition, and fometimes it prevents or retards it.

6. Bergmann has given a formula, or a fort of emblem, to reprefent the action and refult of double decompofitions, which may be employed with much advantage to exhibit what paffes as the effect of double affinities between falts. On the two extremities of a parallelogram, formed by braces with their points outward, he writes externally the names of two falts brought into contact: and within thefe two vertical braces, he puts the conftituent principles of each falt in fuch a manner, that the acid of the one is oppofite to the bafe of the other. Above the fuperior horizontal brace, he places that new formed falt which remains fufpended or diffolved in the water; and under the inferior brace, he puts the other new formed falt, which is feparated from it, or precipitated. For inftance, he reprefents the double decompofition that takes place between fulphate of pot-afh and nitrate of lime in the following manner:

Nitrate of Pot-Afh.

| Sulphate of pot-ash. | Pot-ash. | Nitric acid. | Nitrate of lime. |
| | Sulphuric acid. Lime. | |

Sulphate of Lime.

7. Mr.
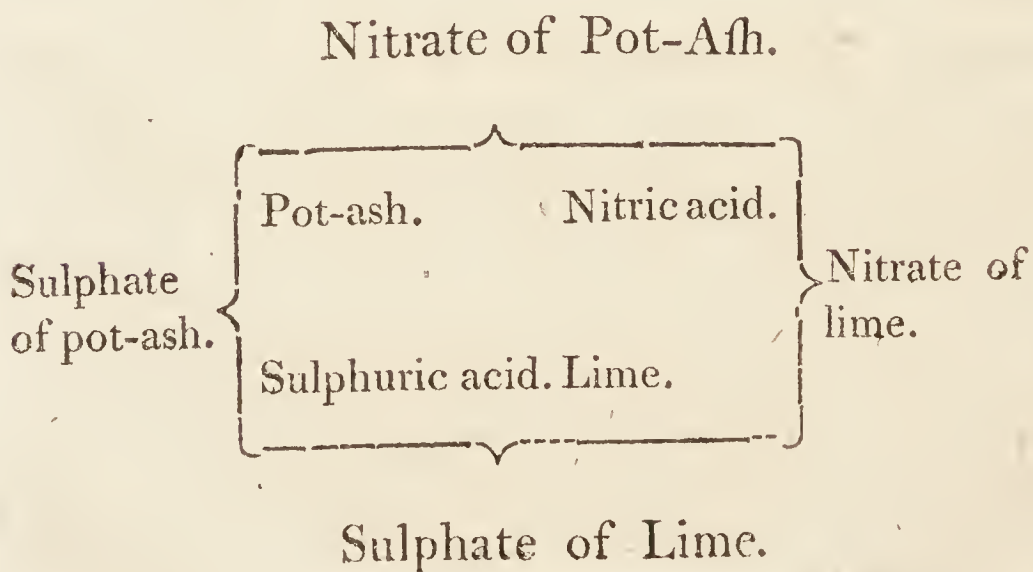
7. Mr. Kirwan, employing the fame repre
fentation or formula, has added to it the terms
of quiefcent and divellent attractions, to fhow,
that the latter overcome the former, and to ex-
prefs the direction in which thefe attractions
operate; as appears in the fubfequent example
of nitrate of barites decompofed by carbonate of
foda.

Nitrate of Soda.

Nitric acid.   Soda.

Nitrate
of   (Quiescent   attractions.)   Carbonate
barites.   of Soda.

Barites.   Carbonic acid.

(Divellent   attractions.)
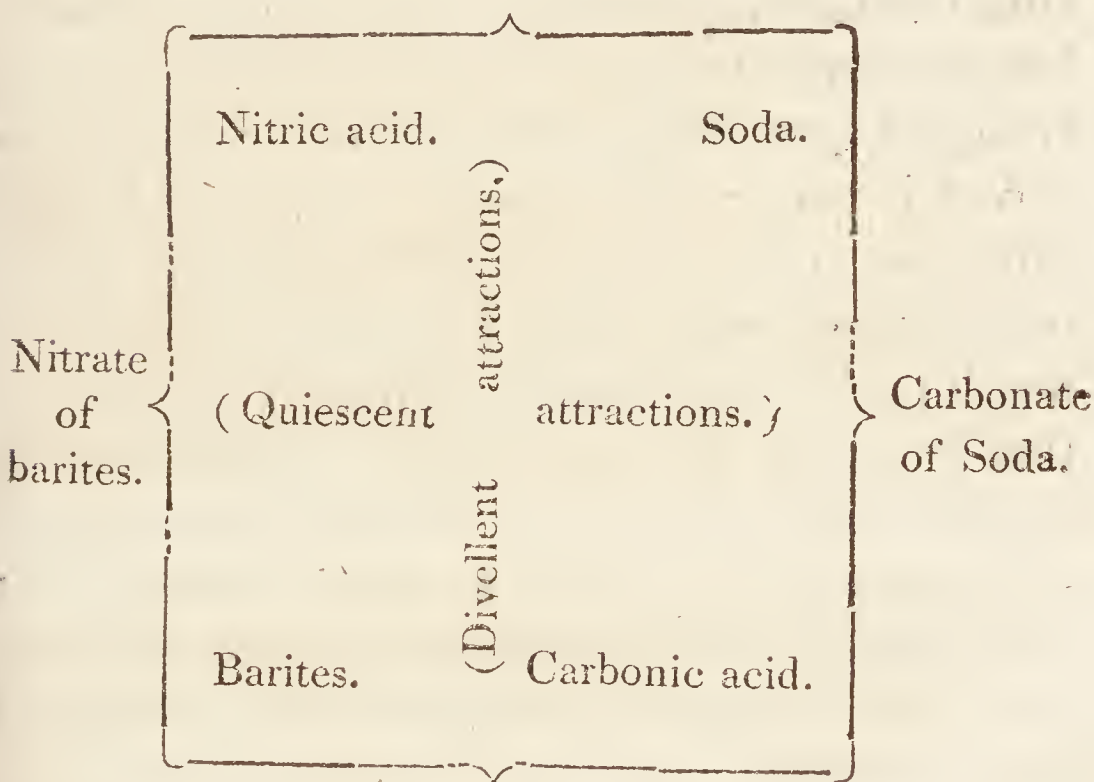
Carbonate of Barites.

I have long attempted to do ftill more for the
perfpicuity and fignificance of thefe emblems,
by employing different numbers to exprefs each
chemical attraction, taking care that they fhould
agree with obfervation, fo that the form of the di-
vellent attractions fhould exceed that of the
N 2   quiefcent.

quiefcent. But this attempt, which is ftill very vague and uncertain, I have been able to make only with a few of the firft data, between a fmall number of acids and of bafes, as may be feen in the volume of Memoirs of Chemiftry, which I publifhed in 1784. The number of thefe bodies, fo aftonifhingly increafed by the difcoveries made fince that period, would require, at prefent, the employment of methods much more exact, than it was in my power to adopt at that time, to appreciate the relative powers of the affinities exifting between the acids and bafes. Simple conjectures, or numbers of convention arranged according to the general relations perceived between thefe affinities, being no longer fufficient, I cannot now perfift in the execution of this plan, which would require inveftigations much more numerous and difficult than thofe that have hitherto been made. I fhall content myfelf, therefore, with giving fuch double decompofitions of falts as have come to my knowledge, by arranging in one table the hundred and thirty-five fpecies of falts, which I have defcribed.

8. In this table, the number of double decompofitions will be feen to amount to one thoufand feven hundred and fix, without including thofe of the nitrites, fuper-oxigenated muriates, and phofphites, which I have not yet been able to examine feparately, on account of the little knowledge yet collected, refpecting the fpecies of falts here exhibited for the firft time.

time in a methodical and fyftematic work on chemiftry. Of thefe 1760 decompofitions, moft of which are owing to fuperfluous double attractions, there are a certain number, which, not having been thoroughly confirmed by accurate experiments, but merely inferred from the well known order of attractions, have been noted as conjectural, or fimply probable, by placing a note of interrogation after the decompofing falt.

The table which exhibits thefe double attractions and decompofitions is conftructed on a fimple plan, and eafy to be underftood. Every falt is confidered in it feparately, under a number correfponding to that of the rank it occupies in the feries of faline fubftances from I to CXXXV, the whole number of thefe compounds. The fpecies noticed, is fuppofed to be placed in contact with all thofe that follow it; fo that the number of thofe by which each fpecies is treated in fucceffion, decreafes as we advance.

The enumeration of the double decompofitions of each fpecies of falts, is feparated from that of the preceding by a fhort line. The number and names of the fpecies treated of in each of thefe decifions, are printed in Roman numerals and fmall capitals, while thofe of the decompofing fpecies are in arabic figures and Italics.

For the reft, the infpection and flighteft ftudy of the table will give a better idea of the plan, and of the methods of abbreviation employed,

than

than could be done by the moft prolix intro-
ductory explanation.

*A Table of the reciprocal double Decompofitions.
which take Place between the hundred and
thirty-five fpecies of alkaline and earthy
Salts defcribed in this Section.*

I. SULPHATE OF BARITES.

Of the 134 fpecies of falts following this,
there are but two, by which it is decompofed.

1. *Carbonate of Pot-Afh.*

The products are $\begin{cases} \text{fulphate of pot-afh.} \\ \text{carbonate of barites.} \end{cases}$
Neceffary attraction.

2. *Carbonate of Soda.*

The products are $\begin{cases} \text{fulphate of foda.} \\ \text{carbonate of barites.} \end{cases}$
Neceffary attraction.

II. SULPHATE OF POT-ASH.

It is decompofed by the fourteen following.

1. Sul-

1. *Sulphite of Barites.*

The products are $\begin{cases} \text{fulphite of pot-afh.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

2. *Nitrate of Barites.*

The products are $\begin{cases} \text{nitrate of pot-afh.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

3. *Nitrate of Strontian.*

The products are $\begin{cases} \text{nitrate of pot-afh.} \\ \text{fulphate of ftrontian.} \end{cases}$
Neceffary attraction.

4. *Nitrate of Lime.*

The products are $\begin{cases} \text{nitrate of pot-afh.} \\ \text{fulphate of lime.} \end{cases}$
Neceffary attraction.

5, 6, 7.

The three *nitrites* of *barites,* *ftrontian,* and *lime.* For the nitrates produced in the three preceding examples, fubftitute nitrites: the ful-

phates

phates precipitated, are the fame as in thofe examples.

8. *Muriate of Barites.*

The products are $\begin{cases} \text{muriate of pot-afh.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

9. *Muriate of Strontian.*

The products are $\begin{cases} \text{muriate of pot-afh.} \\ \text{fulphate of ftrontian.} \end{cases}$

Neceffary attraction.

10. *Muriate of Lime.*

The products are $\begin{cases} \text{muriate of pot-afh.} \\ \text{fulphate of lime.} \end{cases}$

Neceffary Attraction.

11. *Phofphate of Barites.*

The products are $\begin{cases} \text{phofphate of pot-afh.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

12. *Phofphite of Barites.*

The products are $\begin{cases} \text{phofphite of pot-afh.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

13. *Fluate*

13. *Fluate of Barites.*

The products are $\left\{\begin{array}{l}\text{fluate of pot-afh.}\\\text{fulphate of barites.}\end{array}\right.$

Superfluous attraction.

14. *Borate of Barites.*

The products are $\left\{\begin{array}{l}\text{borate of pot-afh.}\\\text{fulphate of barites.}\end{array}\right.$

Superfluous attraction.

III. Acid Sulphate of Pot-ash.

This is decompofed by the greater part of the fpecies that follow it, in confequence of the excefs of acid it contains. Thus to the double decompofitions of the preceding it adds the phenomenon of a number of fimple decompofitions effected by its excefs of acid.

IV. Sulphate of Soda.

It is decompofed by the twenty three following.

1. *Sulphite*

1. *Sulphite of Barites.*

The products are $\begin{cases} \text{fulphite of foda.} \\ \text{fulphate of barites} \end{cases}$
Superfluous attraction.

2. *Sulphite of Pot-Afh.*

The products are $\begin{cases} \text{fulphite of foda.} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

3. *Nitrate of Barites.*

The products are $\begin{cases} \text{nitrate of foda.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

4. *Nitrate of Pot-Afh.*

The products are $\begin{cases} \text{nitrate of foda.} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

5. *Nitrate of Strontian.*

The products are $\begin{cases} \text{nitrate of foda.} \\ \text{fulphate of ftrontian.} \end{cases}$
Neceffary attraction.

6. *Nitrate*

6. *Nitrate of Lime.*

The products are $\begin{cases} \text{nitrate of foda.} \\ \text{fulphate of lime.} \end{cases}$
Neceffary attraction.

7, 8, 9, 10.

The Nitrites of Barites, Pot-Afh, Strontian, and Lime, act as the nitrates: for the nitrates formed in the four preceding examples fubftitute nitrites; the fulphates formed are the fame.

11. *Muriate of Barites.*

The products are $\begin{cases} \text{muriate of foda.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

12. *Muriate of Pot-Afh.*

The products are $\begin{cases} \text{muriate of foda.} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

13. *Muriate of Strontian.*

The products are $\begin{cases} \text{muriate of foda.} \\ \text{fulphate of ftrontian.} \end{cases}$
Neceffary attraction.

14. *Muriate*

14. *Muriate of Lime.*

The products are $\left\{\begin{array}{l}\text{muriate of foda.} \\ \text{fulphate of lime.}\end{array}\right.$
Neceffary attraction.

15. *Phofphate of Barites.*

The products are $\left\{\begin{array}{l}\text{phofphate of foda.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

16. *Phofphate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{phofphate of foda.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

17. *Phofphite of Barites.*

The products are $\left\{\begin{array}{l}\text{phofphite of foda.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

18. *Phofphite of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{phofphite of foda.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superflous attraction.

3

19. *Fluate*

19. *Fluate of Barites.*

The products are $\begin{cases} \text{fluate of foda.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

20. *Fluate of Pot-Afh.*

The products are $\begin{cases} \text{fluate of foda.} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

21. *Borate of Barites.*

The products are $\begin{cases} \text{borate of foda.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

22. *Borate of Pot-Afh.*

The products are $\begin{cases} \text{borate of foda.} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

23. *Carbonate of Pot-Afh.*

The products are $\begin{cases} \text{carbonate of foda.} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

V. SULPHATE

V. Sulphate of Strontian.

It is decompofed by the twenty-four follow-ing:

1. *Sulphite of Barites.*

The products are $\left\{\begin{array}{l}\text{fulphite of ftrontian.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

2. *Sulphite of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{fulphate of pot-afh.} \\ \text{fulphite of ftrontian.}\end{array}\right.$
Superfluous attraction.

3. *Sulphite of Soda.*

The products are $\left\{\begin{array}{l}\text{fulphate of foda.} \\ \text{fulphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

4. *Nitrate of Barites.*

The products are $\left\{\begin{array}{l}\text{nitrate of ftrontian.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

5. *Muriates*

5. Muriate of Barites.

The products are $\left\{\begin{array}{l}\text{muriate of ftrontian.}\\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

6. Phofphate of Barites.

The products are $\left\{\begin{array}{l}\text{phofphate of ftrontian.}\\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

7. Phofphate of Pot-Afh.

The products are $\left\{\begin{array}{l}\text{fulphate of pot-afh.}\\ \text{phofphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

8. Phofphate of Soda.

The products are $\left\{\begin{array}{l}\text{fulphate of foda.}\\ \text{phofphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

9. Phofphate of Ammonia.

The products are $\left\{\begin{array}{l}\text{fulphate of ammonia.}\\ \text{phofphate of ftrontian.}\end{array}\right.$
Neceffary attraction.

11, 10,

10, 11, 12, 13.

The four *phofphites*, with the fame bafes as the phofphates, decompofe like them the fulphate of ftrontian. For the phofphates fubftitute here phofphites; the fulphates formed are the fame as in the four preceding inftances.

14. *Fluate of Barites.*

The products are $\begin{cases} \text{fluate of ftrontian.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

15. *Fluate of Pot-Afh?*

The products are $\begin{cases} \text{fulphate of pot-afh.} \\ \text{fluate of ftrontian.} \end{cases}$
Superfluous attraction.

16. *Fluate of Soda?*

The products are $\begin{cases} \text{fulphate of foda.} \\ \text{fluate of ftrontian.} \end{cases}$
Superfluous attraction.

17. *Fluate of Ammonia?*

The products are $\begin{cases} \text{fulphate of ammonia.} \\ \text{fluate of ftrontian.} \end{cases}$
Neceffary attraction.

18. *Borate*

18. *Borate of Barites ?*

The products are $\begin{cases} \text{borate of ftrontian.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

19. *Borate of Pot-Afh ?*

The products are $\begin{cases} \text{fulphate of pot-afh.} \\ \text{borate of ftrontian.} \end{cases}$
Superfluous attraction.

20. *Borate of Soda ?*

The products are $\begin{cases} \text{fulphate of foda.} \\ \text{borate of ftrontian.} \end{cases}$
Superfluous attraction.

21. *Borate of Ammonia ?*

The products are $\begin{cases} \text{fulphate of ammonia.} \\ \text{borate of ftrontian.} \end{cases}$
Superfluous attraction.

22. *Carbonate of Barites ?*

The products are $\begin{cases} \text{carbonate of ftrontian.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

23. *Carbonate of Pot-Ash?*

The products are $\left\{\begin{array}{l}\text{fulphate of pot-afh.}\\ \text{carbonate of ftrontian.}\end{array}\right.$

Superfluous attraction.

24. *Carbonate of Soda?*

The products are $\left\{\begin{array}{l}\text{fulphate of foda.}\\ \text{carbonate of ftrontian.}\end{array}\right.$

Superfluous attraction.

VI. SULPHATE OF LIME.

IT is decompofed by the thirty-eight following:

1. *Sulphite of Barites.*

The products are $\left.\begin{array}{l}\text{fulphite of lime.}\\ \text{fulphate of barites.}\end{array}\right\}$

Superfluous attraction.

2. *Sulphite of Pot-Ash.*

The products are $\left\{\begin{array}{l}\text{fulphate of pot-afh.}\\ \text{fulphite of lime.}\end{array}\right.$

Superfluous attraction.

3. *Sulphite*

3. *Sulphite of Soda.*

The products are $\begin{cases} \text{fulphate of foda.} \\ \text{fulphite of lime.} \end{cases}$
Superfluous attraction.

4. *Nitrate of Barites.*

The products are $\begin{cases} \text{nitrate of lime.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

5. *Nitrate of Strontian.*

The products are $\begin{cases} \text{nitrate of lime.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

6. *Nitrite of Barites.*

The products are $\begin{cases} \text{nitrite of lime.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

7. *Nitrite of Strontian.*

The products are $\begin{cases} \text{nitrite of lime.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

O 2

8. Muriate

8. *Muriate of Barites.*

The products are } muriate of lime.
fulphate of barites.
Superfluous attraction.

9. *Muriate of Strontian.*

The products are { muriate of lime.
fulphate of ftrontian.
Superfluous attraction.

10. *Phofphate of Barites.*

The products are { phofphate of lime.
fulphate of barites.
Superfluous attraction.

11. *Phofphate of Strontian.*

The products are { phofphate of lime.
fulphate of ftrontian.
Superfluous attraction.

12. *Phofphate of Pot-Afh.*

The products are { fulphate of pot-afh.
phofphate of lime.
Superfluous attraction.

13. *Phofpha*

13. *Phosphate of Soda.*

The products are $\left\{\begin{array}{l}\text{fulphate of foda.}\\\text{phofphate of lime.}\end{array}\right.$
Superfluous attraction.

14. *Phosphate of Ammonia.*

The products are $\left\{\begin{array}{l}\text{fulphate of ammonia.}\\\text{phofphate of lime.}\end{array}\right.$
Neceffary attraction.

15. *Phosphate of Alumine.*

The products are $\left\{\begin{array}{l}\text{fulphate of alumine.}\\\text{phofphate of lime.}\end{array}\right.$
Neceffary attraction.

16, 17, 18, 19, 20, 21.

The *phofphites* with the bafes of the fix preceding phofphates appear capable, like them, of decompofing the fulphate of lime. The products are phofphite of lime and the fulphates above-mentioned.

22. *Fluate of Barites?*

The products are $\left\{\begin{array}{l}\text{fluate of lime.}\\\text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

23. *Fluate*

23. *Fluate of Strontian ?*

The products are $\begin{cases} \text{fluate of lime.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

24. *Fluate of Magnefia ?*

The products are $\begin{cases} \text{fulphate of magnefia.} \\ \text{fluate of lime.} \end{cases}$
Neceffary attraction.

25. *Fluate of Pot-Afh ?*

The products are $\begin{cases} \text{fulphate of pot-afh.} \\ \text{fluate of li me.} \end{cases}$
Superfluous attraction.

26. *Fluate of Soda.*

The products are $\begin{cases} \text{fulphate of foda.} \\ \text{fluate of lime} \end{cases}$
Superfluous attraction.

27. *Fluate of Ammonia.*

The products are $\begin{cases} \text{fulphate of ammonia.} \\ \text{fluate of lime.} \end{cases}$
Neceffary attraction.

28. *Borate*

28. *Borate of Barites.*

The products are $\left\{\begin{array}{l}\text{borate of lime.}\\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

29. *Borate of Strontian.*

The products are $\left\{\begin{array}{l}\text{borate of lime.}\\ \text{fulphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

30. *Borate of Magnefia.*

The products are $\left\{\begin{array}{l}\text{fulphate of magnefia.}\\ \text{borate of lime.}\end{array}\right.$
Neceffary attraction.

31. *Borate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{fulphate of pot-afh.}\\ \text{borate of lime.}\end{array}\right.$
Superfluous attraction.

32. *Borate of Soda.*

The products are $\left\{\begin{array}{l}\text{fulphate of foda.}\\ \text{borate of lime.}\end{array}\right.$
Superfluous attraction.

33. *Borate*

33 *Borate of Ammonia.*

The products are $\begin{cases} \text{fulphate of ammonia.} \\ \text{borate of lime.} \end{cases}$

Neceſſary attraction.

34. *Carbonate of Barites ?*

The products are $\begin{cases} \text{carbonate of lime.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

35. *Carbonate of Strontian ?*

The products are $\begin{cases} \text{carbonate of lime.} \\ \text{fulphate of ftrontian.} \end{cases}$

Superfluous attraction.

36. *Carbonate of Pot-Aſh.*

The products are $\begin{cases} \text{fulphate of pot-afh.} \\ \text{carbonate of lime.} \end{cases}$

Superfluous attraction.

37. *Carbonate of Soda.*

The products are $\begin{cases} \text{fulphate of foda.} \\ \text{carbonate of lime.} \end{cases}$

Superfluous attraction.

38. *Carbonate*

38. *Carbonate of Ammonia.*

The products are $\left\{\begin{array}{l}\text{fulphate of ammonia.} \\ \text{carbonate of lime.}\end{array}\right.$
Neceffary attraction.

———

VII. Sulphate of Ammonia.

It is decompofed by the forty-nine following:

1. *Sulphite of Barites.*

The products are $\left\{\begin{array}{l}\text{fulphite of ammonia.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

2. *Sulphate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{fulphite of ammonia.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

3. *Sulphite of Soda.*

The products are $\left\{\begin{array}{l}\text{fulphite of ammonia.} \\ \text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

4. *Sulphite*

4. *Sulphite of Strontian.*

The products are $\left\{ \begin{array}{l} \text{fulphite of ammonia,} \\ \text{fulphate of ftrontian,} \end{array} \right.$
Superfluous attraction.

5. *Sulphite of Magnefia,*

The products are $\left\{ \begin{array}{l} \text{fulphite of ammonia,} \\ \text{fulphate of magnefia,} \end{array} \right.$
When cold they unite into a triple falt.
Neceffary Attraction.

6. *Nitrate of Barites.*

The products are $\left\{ \begin{array}{l} \text{nitrate of ammonia,} \\ \text{fulphate of barites,} \end{array} \right.$
Superfluous attraction.

7. *Nitrate of Pot-Afh?*

The products are $\left\{ \begin{array}{l} \text{nitrate of ammonia,} \\ \text{fulphate of pot-afh,} \end{array} \right.$
Superfluous attraction.

8. *Nitrate of Soda?*

The products are $\left\{ \begin{array}{l} \text{nitrate of ammonia,} \\ \text{fulphate of foda.} \end{array} \right.$
Superfluous attraction.

9. *Nitrate*

9. *Nitrate of Strontian.*

The products are $\left\{\begin{array}{l}\text{nitrate of ammonia.}\\\text{fulphate of ftrontian.}\end{array}\right.$

Superfluous attraction.

10. *Nitrate of Lime.*

The products are $\left\{\begin{array}{l}\text{nitrate of ammonia.}\\\text{fulphate of lime.}\end{array}\right.$

Superfluous attraction.

11. *Nitrate of Magnefia.*

With heat the products are $\left\{\begin{array}{l}\text{nitrate of ammonia.}\\\text{fulphate of magnefia.}\end{array}\right.$

When cold the decompofition is doubtful.

Neceffary attraction.

12. *Ammoniaco-magnefian Nitrate.*

The products are $\left\{\begin{array}{l}\text{nitrate of ammonia.}\\\text{ammoniaco-magnefian}\\\text{fulphate.}\end{array}\right.$

Neceffary attraction.

13, 14, 15, 16, 17, 18, 19.

The feven *nitrites,* with the fame bafes as the preceding nitrates, appear to decompofe the fulphate of ammonia in a fimilar manner.

4

20. *Muriate*

20. *Muriate of Barites.*

The products are $\left\{\begin{array}{l}\text{muriate of ammonia.}\\\text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

21. *Muriate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{muriate of ammonia.}\\\text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

22. *Muriate of Soda.*

The products are $\left\{\begin{array}{l}\text{muriate of ammonia.}\\\text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

23. *Muriate of Strontian.*

The products are $\left\{\begin{array}{l}\text{muriate of ammonia.}\\\text{fulphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

24. *Muriate of Lime.*

The products are $\left\{\begin{array}{l}\text{muriate of ammonia.}\\\text{fulphate of lime.}\end{array}\right.$
Superfluous attraction.

25. *Muriate*

25. *Muriate of Magnefia.*

The products are $\begin{cases} \text{muriate of magnefia.} \\ \text{ammoniaco-magnefian ful-} \\ \quad \text{phate.} \end{cases}$

Neceffary attraction.

26. *Ammoniaco-Magnefian Muriate.*

The products are $\begin{cases} \text{muriate of ammonia.} \\ \text{ammoniaco-magnefian} \\ \quad \text{fulphate.} \end{cases}$

Superfluous attraction.

27. *Muriate of Alumine.*

The products are $\begin{cases} \text{muriate of ammonia.} \\ \text{ammoniaco-aluminous ful-} \\ \text{phate, or ammoniacal alum.} \end{cases}$

Neceffary attraction

28. *Phofphate of Barites.*

The products are $\begin{cases} \text{phofphate of ammonia.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

29. **Phofphate**

29. *Phosphate of Pot-Ash.*

The products are $\begin{cases} \text{phofphate of ammonia,} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

30. *Phosphate of Soda.*

The products are $\begin{cases} \text{phofphate of ammonia,} \\ \text{fulphate of foda.} \end{cases}$

Superfluous attraction.

31. *Phosphate of Soda and Ammonia.*

The products are $\begin{cases} \text{phofphate of ammonia,} \\ \text{fulphate of foda.} \end{cases}$

Superfluous attraction.

32, 33, 34, 35.

The four *phosphites*, with the fame bafes as the phofphates decompofe in like manner the fulphate of ammonia: the products are the fame fulphates as above, and *phosphite* inftead of phofphate of ammonia.

36. *Fluate of Barites.*

The products are $\begin{cases} \text{fluate of ammonia,} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

37. *Fluate*

37. *Fluate of Strontian.*

The products are $\begin{cases} \text{fluate of ammonia.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

38. *Fluate of Pot-Afh.*

The products are $\begin{cases} \text{fluate of ammonia,} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

39. *Fluate of Soda.*

The products are $\begin{cases} \text{fluate of ammonia,} \\ \text{fulphate of foda.} \end{cases}$
Superfluous attraction.

40. *Siliceous Fluate of Soda.*

The products are $\begin{cases} \text{ammoniaco-filiceous fluate.} \\ \text{fulphate of foda.} \end{cases}$
Superfluous attraction.

41. *Borate of Barites.*

The products are $\begin{cases} \text{ammoniacal borate.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

42. *Borate*

42. *Borate of Pot-Afh.*

The products are $\begin{cases} \text{borate of ammonia.} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

43. *Borate of Soda.*

The products are $\begin{cases} \text{borate of ammonia.} \\ \text{fulphate of foda.} \end{cases}$

Superfluous attraction.

44. *Carbonate of Barites.*

The products are $\begin{cases} \text{carbonate of ammonia.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

45. *Carbonate of Strontian.*

The products are $\begin{cases} \text{carbonate of ammonia.} \\ \text{fulphate of ftrontian.} \end{cases}$

Superfluous attraction.

46. *Carbonate of Lime.*

The products are $\begin{cases} \text{carbonate of ammonia} \\ \text{fulphate of lime.} \end{cases}$

Neceffary attraction.

47. *Carbonate*

47. Carbonate of Pot-Ash.

The products are { carbonate of ammonia.
fulphate of pot-afh.
Superfluous attraction.

48. Carbonate of Soda.

The products are { carbonate of ammonia.
fulphate of foda.
Superfluous attraction.

49. Carbonate of Magnefia.

With heat the pro-
ducts are { carbonate of ammonia.
fulphate of magnefia.
Neceffary attraction.

VIII. SULPHATE OF MAGNESIA.

It is decompofed by the forty-fix follow-
ing:

　　　　1. Sulphite

1. *Sulphite of Barites.*

The products are $\left\{\begin{array}{l}\text{fulphite of magnefia.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

2. *Sulphite of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{fulphite of magnefia.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

3. *Sulphite of Soda.*

The products are $\left\{\begin{array}{l}\text{fulphite of magnefia.} \\ \text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

4. *Sulphite of Strontian.*

The products are $\left\{\begin{array}{l}\text{fulphite of magnefia.} \\ \text{fulphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

5. *Sulphite of Ammonia.*

The products are $\left\{\begin{array}{l}\text{fulphite of magnefia.} \\ \text{ammoniaco-magnefia ful-} \\ \text{phate.}\end{array}\right.$
Neceffary attraction.

6. *Nitrate*

6. *Nitrate of Barites.*

The products are $\begin{cases} \text{nitrate of magnefia.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

7. *Nitrate of Pot-Afh.*

The products are $\begin{cases} \text{nitrate of magnefia.} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

8. *Nitrate of Soda.*

The products are $\begin{cases} \text{nitrate of magnefia.} \\ \text{fulphate of foda.} \end{cases}$

Superfluous attraction.

9. *Nitrate of Strontian.*

The products are $\begin{cases} \text{nitrate of magnefia.} \\ \text{fulphate of ftrontian.} \end{cases}$

Superfluous attraction.

10. *Nitrite of Lime.*

The products are $\begin{cases} \text{nitrate of magnefia.} \\ \text{fulphate of lime.} \end{cases}$

Superfluous attraction.

P 2

11. *Nitrate of Ammonia.*

The products are $\begin{cases} \text{nitrate of magnefia.} \\ \text{ammoniaco-magnefian} \\ \text{fulphate.} \end{cases}$

Neceffary attraction.

12, 13, 14, 15, 16, 17.

The fix *Nitrites*, with the fame bafes as the preceding nitrates, act like them on the fulphate of magnefia, and decompofe it in a fimilar manner. In thefe decompofitions nitrite of magnefia is conftantly produced, with different fulphates, according to the fpecies of the nitrites employed.

18. *Muriate of Barites.*

The products are $\begin{cases} \text{muriate of magnefia.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

19. *Muriate of Strontian.*

The products are $\begin{cases} \text{muriate of magnefia.} \\ \text{fulphate of ftrontian.} \end{cases}$

Superfluous attraction.

20. *Muriate*

20. *Muriate of Lime.*

The products are $\left\{\begin{array}{l}\text{muriate of magnefia.} \\ \text{fulphate of lime.}\end{array}\right.$
Superfluous attraction.

21. *Phofphate of Barites.*

The products are $\left\{\begin{array}{l}\text{phofphate of magnefia.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

22. *Phofphate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{phofphate of magnefia.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

23. *Phofphate of Soda.*

The products are $\left\{\begin{array}{l}\text{phofphate of magnefia.} \\ \text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

24. *Phofpate of Strontian ?*

The products are $\left\{\begin{array}{l}\text{phofphate of magnefia.} \\ \text{fulphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

25. *Phofphate*

25. *Poſphate of Ammonia.*

The products are $\begin{cases} \text{phoſphate of magneſia.} \\ \text{ammoniaco-magneſian} \\ \text{ſulphate.} \end{cases}$

Superfluous attraction.

26, 27, 28, 29, 30.

The five *phoſphites* analogous to the preced‑ing phoſphates with reſpect to their baſes de‑compoſe the ſulphate of magneſia in the ſame manner, and phoſphite of magneſia is formed.

31. *Fluate of Barites.*

The products are $\begin{cases} \text{fluate of magneſia.} \\ \text{ſulphate of barites.} \end{cases}$

Superfluous attraction.

32. *Fluate of Strontian.*

The products are $\begin{cases} \text{fluate of magneſia.} \\ \text{ſulphate of ſtrontian.} \end{cases}$

Superfluous attraction.

33. *Fluate*

33. *Fluate of Pot-Aſh.*

The products are $\begin{cases} \text{fluate of magnefia.} \\ \text{fulphate of pot-aſh.} \end{cases}$
Superfluous attraction.

34. *Fluate of Soda.*

The products are $\begin{cases} \text{fluate of magnefia.} \\ \text{fulphate of foda.} \end{cases}$
Superfluous attraction.

35. *Fluate of Ammonia?*

The products are $\begin{cases} \text{fluate of magnefia.} \\ \text{fulphate of ammonia.} \end{cases}$
Neceſſary attraction.

36. *Borate of Barites.*

The products are $\begin{cases} \text{borate of magnefia.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

37. *Borate of Strontian.*

The products are $\begin{cases} \text{borate of magnefia.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

38. *Borate of Pot-Aſh.*

The products are $\begin{cases} \text{magnefian borate.} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

39. *Borate of Soda.*

The products are $\begin{cases} \text{borate of magnefia.} \\ \text{fulphate of foda.} \end{cases}$

Superfluous attraction.

40. *Borate of Ammonia.*

The products are $\begin{cases} \text{magnefian borate.} \\ \text{ammoniaco-magnefian} \\ \text{fulphate.} \end{cases}$

Neceſſary attraction.

41. *Carbonate of Barites.*

The products are $\begin{cases} \text{carbonate of magnefia.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

42. *Carbonate of Strontian.*

The products are $\begin{cases} \text{carbonate of magnefia.} \\ \text{fulphate of ftrontian.} \end{cases}$

Superfluous attraction.

3

43. *Carbonate of Lime.*

The products are $\begin{cases} \text{carbonate of magnefia.} \\ \text{fulphate of lime.} \end{cases}$

Superfluous attraction.

44. *Carbonate of Pot-Afh.*

The products are $\begin{cases} \text{fulphate of pot-afh.} \\ \text{carbonate of magnefia.} \end{cases}$

Superfluous attraction.

45. *Carbonate of Soda.*

The products are $\begin{cases} \text{fulphate of foda.} \\ \text{carbonate of magnefia.} \end{cases}$

Superfluous attraction.

46. *Carbonate of Ammonia.*

The products are $\begin{cases} \text{fulphate of ammonia.} \\ \text{carbonate of magnefia.} \end{cases}$

Neceffary attraction.

IX.

IX. AMMONIACO-MAGNESIAN SULPHATE.

It is decompofed by the forty-one following.

1. *Sulphite of Barites.*

The products are $\begin{cases} \text{the triple fulphite.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

2. *Sulphite of Pot-Afh.*

The products are $\begin{cases} \text{the triple fulphite.} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

3. *Sulphite of Soda.*

The products are $\begin{cases} \text{the triple fulphite} \\ \text{fulphate of foda.} \end{cases}$
Superfluous attraction.

4. *Sulphite of Strontian.*

The products are $\begin{cases} \text{the triple fulphite.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

5. *Nitrate*

5. *Nitrate of Barites.*

The products are $\left\{\begin{array}{l}\text{the triple nitrate}\\\text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

6. *Nitrate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{the triple nitrate,}\\\text{fulphate of pot-afh,}\end{array}\right.$
Superfluous attraction.

7. *Nitrate of Soda.*

The products are $\left\{\begin{array}{l}\text{the triple nitrate,}\\\text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

8. *Nitrate of Strontian.*

The products are $\left\{\begin{array}{l}\text{the triple nitrate.}\\\text{fulphate of ftrontian,}\end{array}\right.$
Superfluous attraction.

9. *Nitrate of Lime.*

The products are $\left\{\begin{array}{l}\text{the triple nitrate.}\\\text{fulphate of lime.}\end{array}\right.$
Superfluous attraction.

10, 11,

10, 11, 12, 13, 14.

The five *nitrites*, with the fame bafes as the preceding nitrates, decompofe, like them, the ammoniaco-magnefian fulphate: the products are the triple nitrite and the fame fulphates as above.

15. *Muriate of Barites.*

The products are $\begin{cases} \text{the triple muriate.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

16. *Muriate of Pot-Afh.*

The products are $\begin{cases} \text{the triple muriate.} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

17. *Muriate of Soda.*

The products are $\begin{cases} \text{the triple muriate.} \\ \text{fulphate of foda.} \end{cases}$

Superfluous attraction.

18. *Muriate of Strontian.*

The products are $\begin{cases} \text{the triple muriate.} \\ \text{fulphate of ftrontian.} \end{cases}$

Superfluous attraction.

19. *Muriate*

19. *Muriate of Lime.*

The products are $\left\{\begin{array}{l}\text{the triple muriate.} \\ \text{fulphate of lime.}\end{array}\right.$
Superfluous attraction.

20. *Phofphate of Barites.*

The products are $\left\{\begin{array}{l}\text{the triple phofphate.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

21. *Phofphate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{the triple phofphate.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

22. *Phofphate of Soda.*

The products are $\left\{\begin{array}{l}\text{the triple phofphate.} \\ \text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

23, 24, 25.

The three *phofphites*, with the fame bafes as the preceding phofphates, decompofe, like them, the ammoniaco-magnefian fulphate,

26. *Fluate*

26. *Fluate of Barites.*

The products are $\begin{cases} \text{the triple fluate.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

27. *Fluate of Strontian.*

The products are $\begin{cases} \text{the triple fluate.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

28. *Fluate of Pot-Aſh.*

The products are $\begin{cases} \text{the triple fluate.} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

29. *Fluate of Soda.*

The products are $\begin{cases} \text{the triple fluate.} \\ \text{fulphate of foda.} \end{cases}$
Superfluous attraction.

30. *Fluate of Ammonia ?*

The products are $\begin{cases} \text{fluate of magnefia.} \\ \text{fulphate of ammonia.} \end{cases}$
Neceffary attraction.

31. *Borate*

31. *Borate of Barites.*

The products are $\left\{\begin{array}{l}\text{the triple borate.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

32. *Borate of Strontian.*

The products are $\left\{\begin{array}{l}\text{the triple borate.} \\ \text{fulphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

33. *Borate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{the triple borate.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

34. *Borate of Soda.*

The products are $\left\{\begin{array}{l}\text{the triple borate.} \\ \text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

35. *Borate of Ammonia ?*

The products are $\left\{\begin{array}{l}\text{ammoniacal fulphate.} \\ \text{borate of magnefia.}\end{array}\right.$
Neceffary Attraction.

4   36. *Carbonate*

36. *Carbonate of Barites.*

The products are $\begin{cases} \text{the triple carbonate.} \\ \text{fulphate of barites.} \end{cases}$

Superfluous attraction.

37. *Carbonate of Strontian.*

The products are $\begin{cases} \text{the triple carbonate.} \\ \text{fulphate of ftrontian.} \end{cases}$

Superfluous attraction.

38. *Carbonate of Lime.*

Not cold.

With heat the products are $\begin{cases} \text{carbonate of ammonia.} \\ \text{carbonate of magnefia.} \\ \text{fulphate of lime.} \end{cases}$

Neceffary attraction.

39. *Carbonate of Pot-Afh.*

The products are $\begin{cases} \text{the triple carbonate.} \\ \text{fulphate of pot-afh.} \end{cases}$

Superfluous attraction.

40 *Carbonate of Soda.*

The products are $\begin{cases} \text{the triple carbonate.} \\ \text{fulphate of foda.} \end{cases}$

Superfluous attraction.

41. *Carbonate of Magnefia.*

With heat the pro- { carbonate of ammonia.
ducts are { fulphate of magnefia.
Neceffary attraction.

———

X. SULPHATE OF GLUCINE.

IT is decompofed by the fifty-feven fol-
lowing :

1. *Sulphite of Barites.*

The products are { fulphite of glucine.
{ fulphate of barites.
Superfluous attraction.

2. *Sulphite of Pot-Afh.*

The products are { fulphite of glucine.
{ fulphate of pot-afh.
Superfluous attraction.

3. *Sulphite of Soda.*

The products are { fulphite of glucine.
{ fulphate of foda.
Superfluous attraction.

4. *Sulphite*

4. *Sulphite of Strontian.*

The products are $\begin{cases} \text{sulphite of glucine.} \\ \text{sulphate of strontian.} \end{cases}$
Superfluous attraction.

5. *Nitrate of Barites.*

The products are $\begin{cases} \text{nitrate of glucine.} \\ \text{sulphate of barites.} \end{cases}$
Superfluous attraction.

6. *Nitrate of Pot-Ash.*

The products are $\begin{cases} \text{nitrate of glucine.} \\ \text{sulphate of pot-ash.} \end{cases}$
Superfluous attraction.

7. *Nitrate of Soda.*

The products are $\begin{cases} \text{nitrate of glucine.} \\ \text{sulphate of soda.} \end{cases}$
Superfluous attraction.

8. *Nitrate of Strontian.*

The products are $\begin{cases} \text{nitrate of glucine.} \\ \text{sulphate of strontian.} \end{cases}$
Superfluous attraction.

9. *Nitrate*

9. *Nitrate of Lime.*

The products are { nitrate of glucine.
{ fulphate of lime.
Superfluous attraction.

10. *Nitrate of Ammonia.*

The products are { nitrate of glucine.
{ fulphate of ammonia.
Superfluous attraction.

11. *Nitrate of Magnefia.*

The products are { nitrate of glucine.
{ fulphate of magnefia.
Superfluous attraction.

12. *Ammoniaco-magnefian Nitrate.*

The products are { nitrate of glucine.
{ ammoniaco-magnefian
{ fulphate.
Superfluous attraction.

13, 14, 15, 16, 17, 18, 19, 20.

The eight *nitrites*, with the fame bafes as the preceding nitrates, decompofe, like them, the fulphate of glucine. Nitrite of glucine is

Q 2   formed

formed inſtead of the nitrate, and the ſame ſulphates as above.

21. *Muriate of Barites.*

The products are { muriate of glucine.
                  { ſulphate of barites.
Superfluous attraction.

22. *Muriate of Pot-Aſh.*

The products are { muriate of glucine.
                  { ſulphate of pot-aſh.
Superfluous attraction.

23. *Muriate of Soda.*

The products are { muriate of glucine.
                  { ſulphate of ſoda.
Superfluous attraction.

24. *Muriate of Strontian.*

The products are { muriate of glucine.
                  { ſulphate of ſtrontian.
Superfluous attraction.

25. *Muriate of Lime.*

The products are { muriate of glucine.
                  { ſulphate of lime.
Superfluous attraction.

26. *Muriate*

26. *Muriate of Ammonia.*

The products are $\begin{cases} \text{muriate of glucine.} \\ \text{fulphate of ammonia.} \end{cases}$
Superfluous attraction.

27. *Muriate of Magnefia.*

The products are $\begin{cases} \text{muriate of glucine.} \\ \text{fulphate of magnefia.} \end{cases}$
Superfluous attraction.

28. *Ammoniaco-Magnefian Muriate.*

The products are $\begin{cases} \text{muriate of glucine} \\ \text{ammoniaco-magnefian} \\ \text{fulphate.} \end{cases}$
Superfluous attraction.

29. *Phofphate of Barites.*

The products are $\begin{cases} \text{phofphate of glucine.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

30. *Phofphate of Strontian.*

The products are $\begin{cases} \text{phofphate of glucine.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

31. *Phofphate*

31. *Phosphate of Pot-Ash.*

The products are $\begin{cases} \text{phosphate of glucine,} \\ \text{sulphate of pot-ash.} \end{cases}$

Superfluous attraction.

32. *Phosphate of Soda.*

The products are $\begin{cases} \text{phosphate of glucine} \\ \text{sulphate of pot-ash,} \end{cases}$

Superfluous attraction.

33. *Phosphate of Ammonia.*

The products are $\begin{cases} \text{phosphate of glucine,} \\ \text{sulphate of ammonia,} \end{cases}$

Superfluous attraction.

34. *Phosphate of Magnesia.*

The products are $\begin{cases} \text{phosphate of glucine.} \\ \text{sulphate of magnesia,} \end{cases}$

Superfluous attraction.

35, 36, 37, 38, 39, 40.

The six *phosphites*, with the same bases as the phosphates, equally decompose the sulphate of glucine, forming phosphite instead of phosphate, and the sulphates as above.

41. *Fluate*

41. *Fluate of Barites.*

The products are $\left\{\begin{array}{l}\text{fluate of glucine.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

42. *Fluate of Strontian.*

The products are $\left\{\begin{array}{l}\text{fluate of glucine.} \\ \text{fulphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

43. *Fluate of Magnefia.*

The products are $\left\{\begin{array}{l}\text{fluate of glucine.} \\ \text{fulphate of magnefia.}\end{array}\right.$
Superfluous attraction.

44. *Fluate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{fluate of glucine.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

45. *Fluate of Soda.*

The products are $\left\{\begin{array}{l}\text{fluate of glucine.} \\ \text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

46. *Fluate*

46. *Fluate of Ammonia.*

The products are $\begin{cases} \text{fluate of glucine.} \\ \text{fulphate of ammonia.} \end{cases}$
Superfluous attraction.

47. *Borate of Barites.*

The products are $\begin{cases} \text{borate of glucine.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

48. *Borate of Pot-Afh.*

The products are $\begin{cases} \text{borate of glucine.} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

49. *Borate of Soda.*

The products are $\begin{cases} \text{borate of glucine.} \\ \text{fulphate of foda.} \end{cases}$
Superfluous attraction.

50. *Borate of Ammonia.*

The products are $\begin{cases} \text{borate of glucine.} \\ \text{fulphate of ammonia.} \end{cases}$
Superfluous attraction.

51. *Carbonate*

51. *Carbonate of Barites.*

The products are { carbonate of glucine.
{ fulphate of barites.
Superfluous attraction.

52. *Carbonate of Strontian.*

The products are { carbonate of glucine.
{ fulphate of ftrontian.
Superfluous attraction.

53. *Carbonate of Lime.*

The products are { carbonate of glucine.
{ fulphate of lime.
Superfluous attraction.

54. *Carbonate of Pot-Afh.*

The products are { carbonate of glucine.
{ fulphate of pot-afh.
Superfluous attraction.

55. *Carbonate of Soda.*

The products are { fulphate of foda.
{ carbonate of glucine.
Superfluous attraction.

56. *Carbonate*

56. *Carbonate of Magnesia.*

The products are $\begin{cases} \text{fulphate of magnefia.} \\ \text{carbonate of glucine.} \end{cases}$
Superfluous attraction.

57. *Carbonate of Ammonia.*

The products are $\begin{cases} \text{fulphate of ammonia.} \\ \text{carbonate of glucine.} \end{cases}$
Superfluous attraction.

XI. SULPHATE OF ALUMINE.

IT is decompofed by the fixty-four following.

1. *Sulphite of Barites.*

The products are $\begin{cases} \text{fulphite of alumine.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

2. *Sulphite of Pot-Afh.*

The products are $\begin{cases} \text{fulphite of alumine.} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

3. *Sulphite*

3. *Sulphite of Soda.*

The products are $\begin{cases} \text{fulphite of alumine.} \\ \text{fulphate of foda.} \end{cases}$
Superfluous attraction.

4. *Sulphite of Strontian.*

The products are $\begin{cases} \text{fulphite of alumine.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

5. *Sulphite of Ammonia.*

The products are $\begin{cases} \text{aluminous fulphite.} \\ \text{fulphate of ammonia.} \end{cases}$
Superfluous attraction.

6. *Sulphite of Magnesia.*

The products are $\begin{cases} \text{aluminous fulphite.} \\ \text{fulphate of magnefia.} \end{cases}$
Superfluous attraction.

7. *Ammoniaco-Magnesian Sulphite.*

The products are $\begin{cases} \text{aluminous fulphite.} \\ \text{ammoniaco-magnefian} \\ \text{fulphate.} \end{cases}$
Superfluous attraction.

2   8. *Sulphite*

8. *Sulphite of Glucine?*

The products are $\begin{cases} \text{aluminous fulphite.} \\ \text{fulphate of glucine.} \end{cases}$

Superfluous attraction.

9. *Nitrate of Barites.*

The products are $\begin{cases} \text{nitrate of alumine.} \\ \text{fulphate of barites,} \end{cases}$

Superfluous attraction.

10. *Nitrate of Pot-Afh.*

It is decompofed in part, and fo far as to form alum, or acid fulphate of alumine, and of pot-afh.

11. *Nitrate of Soda.*

The products are $\begin{cases} \text{nitrate of alumine.} \\ \text{fulphate of foda.} \end{cases}$

Superfluous attraction.

12. *Nitrate of Strontian.*

The products are $\begin{cases} \text{nitrate of alumine.} \\ \text{fulphate of ftrontian.} \end{cases}$

Superfluous attraction.

13. *Nitrate*

13. *Nitrate of Lime.*

The products are $\begin{cases} \text{nitrate of alumine.} \\ \text{fulphate of lime.} \end{cases}$

Superfluous attraction.

14. *Nitrate of Ammonia.*

The products are $\begin{cases} \text{nitrate of alumine.} \\ \text{fulphate of ammonia.} \end{cases}$

Superfluous attraction.

15. *Nitrate of Magnefia.*

The products are $\begin{cases} \text{nitrate of alumine.} \\ \text{fulphate of magnefia.} \end{cases}$

Superfluous attraction.

16. *Ammoniaco-Magnefian Nitrate.*

The products are $\begin{cases} \text{nitrate of alumine.} \\ \text{ammoniaco-magnefian} \\ \text{triple fulphate.} \end{cases}$

This decompofition is limited.
Superfluous attraction.

17, 18, 19, 20, 21, 22, 23, 24.

The eight *nitrites* with the fame bafes as the preceding nitrates appear to decompofe fulphate of alumine in a fimilar manner.

25. *Muriate*

25. *Muriate of Barites.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

26. *Muriate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{fulphate of pot-afh.}\end{array}\right.$
Superfluous attraction.

27. *Muriate of Soda.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{fulphate of foda.}\end{array}\right.$
Superfluous attraction.

28. *Muriate of Strontian.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{fulphate of ftrontian.}\end{array}\right.$
Superfluous attraction.

29. *Muriate of Lime.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{fulphate of lime.}\end{array}\right.$
Superfluous attraction.

30. *Muriate*

30. *Muriate of Ammonia.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{fulphate of ammonia.}\end{array}\right.$
Superfluous attraction.

31. *Muriate of Magnefia.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{fulphate of magnefia.}\end{array}\right.$
Superfluous attraction.

32. *Ammoniaco-Magnefian Muriate.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{ammoniaco-magnefian ful-} \\ \text{phate, and ammoniacated} \\ \text{alum.}\end{array}\right.$
Superfluous attraction.

33. *Muriate of Glucine.*

The products are $\left\{\begin{array}{l}\text{muriate of alumine.} \\ \text{fulphate of glucine.}\end{array}\right.$
Superfluous attraction.

34. *Phofphate of Barites.*

The products are $\left\{\begin{array}{l}\text{phofphate of alumine.} \\ \text{fulphate of barites.}\end{array}\right.$
Superfluous attraction.

35. *Phofphate*

35. *Phosphate of Pot-Ash.*

The products are $\left\{\begin{array}{l}\text{phosphate of alumine.} \\ \text{sulphate of pot-ash.}\end{array}\right.$
Superfluous attraction.

36. *Phosphate of Soda.*

The products are $\left\{\begin{array}{l}\text{phosphate of alumine.} \\ \text{sulphate of soda.}\end{array}\right.$
Superfluous attraction.

37. *Phosphate of Ammonia.*

The products are $\left\{\begin{array}{l}\text{phosphate of alumine.} \\ \text{sulphate of ammonia.}\end{array}\right.$
Superfluous attraction.

38. *Phosphate of Magnesia?*

The products are $\left\{\begin{array}{l}\text{phosphate of alumine.} \\ \text{sulphate of magnesia.}\end{array}\right.$
Superfluous attraction.

39. *Phosphate of Glucine.*

The products are $\left\{\begin{array}{l}\text{phosphate of alumine.} \\ \text{sulphate of glucine.}\end{array}\right.$
Superfluous attraction.

40, 41, 42, 43, 44, 45.

The fix *phofphites*, with the fame bafes as the preceding phofphates, feem to be capable of decompofing, like them, the fulphate of alumine.

46. *Fluate of Barites.*

The products are $\begin{cases} \text{fluate of alumine.} \\ \text{fulphate of barites.} \end{cases}$
Superfluous attraction.

47. *Fluate of Strontian.*

The products are $\begin{cases} \text{fluate of alumine.} \\ \text{fulphate of ftrontian.} \end{cases}$
Superfluous attraction.

48. *Fluate of Magnefia.*

The products are $\begin{cases} \text{fluate of alumine.} \\ \text{fulphate of magnefia.} \end{cases}$
Superfluous attraction.

49. *Fluate of Pot-Afh.*

The products are $\begin{cases} \text{fluate of alumine.} \\ \text{fulphate of pot-afh.} \end{cases}$
Superfluous attraction.

50. *Fluate of Soda.*

The products are $\left\{\begin{array}{l}\text{fluate of alumine.} \\ \text{fulphate of foda.}\end{array}\right.$

Superfluous attraction.

51. *Fluate of Ammonia.*

The products are $\left\{\begin{array}{l}\text{fluate of alumine.} \\ \text{fulphate of ammonia.}\end{array}\right.$

Superfluous attraction.

52. *Fluate of Glucine?*

The products are $\left\{\begin{array}{l}\text{fluate of alumine.} \\ \text{fulphate of glucine.}\end{array}\right.$

Superfluous attraction.

53. *Borate of Barites.*

The products are $\left\{\begin{array}{l}\text{borate of alumine.} \\ \text{fulphate of barites.}\end{array}\right.$

Superfluous attraction.

54. *Borate of Pot-Aſh.*

The products are $\left\{\begin{array}{l}\text{borate of alumine.} \\ \text{fulphate of pot-aſh and} \\ \text{alum.}\end{array}\right.$

Superfluous attraction.

55. *Borate*

55. Borate of Soda.

The products are { borate of alumine.
{ fulphate of foda.

Superfluous attraction.

56. Borate of Ammonia.

The products are { borate of alumine.
{ fulphate of ammonia and
{ ammoniated alum.

Superfluous attraction.

57, 58, 59, 60, 61, 62, 63, 64.

The carbonates of barites, ftrontian, lime, pot-afh, foda, magnefia, ammonia, and glucine, decompofe the fulphate of alumine, and form carbonate of alumine, and the fulphates of each of thofe bafes.

XII. AND XIII.

THE ACID AND ACIDULOUS SULPHATES OF ALUMINE.

THESE are acted upon, like the preceding fpecies, by the other falts; and each of them, like it, prefents the fixty-four double decompofitions exhibited above.

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XIV.

XIV. SULPHATE OF ZIRCONE.

IT is decompofed by the feventy-fix follow-
ing:

1, 2, 3, 4, 5, 6, 7, 8, 9.

The fulphites of barites, pot-afh, foda, ftron-
tian ammonia, magnefia, ammoniaco-magne-
fian glucine, and alumine; in fhort, all the
fulphites, except thofe of lime and zircone,
decompofe the fulphate of zircone.

All thefe decompofitions are effected by fuper-
fluous double attractions, becaufe the bafes of
all thefe fulphites have a greater affinity with
the fulphuric acid than zircone has. The pro-
ducts confift of fulphite of zircone in every
cafe, and the fulphate with the bafe of the de-
compofing fulphite.

10, 11, 12, 13, 14, 15, 16, 17, 18, 19.

The firft ten fpecies of nitrates, or all, except
that with zircone for its bafe, likewife decom-
pofe the fulphate of zircone by fuperfluous dou-
ble attractions. In thefe ten decompofitions the
products are nitrate of zircone and a fulphate,
differing in its bafe according to the decom-
pofing nitrate.

20, 21,

20, 21, 22, 23, 24, 25, 26, 27, 28, 29.

It is the fame with the ten nitrites. Nitrite of zircone is produced in thefe decompofitions, which we infer from the known laws of elective attraction.

30, 31, 32, 33, 34, 35, 36, 37, 38, 39.

The ten fpecies of muriates, formed by the bafes which have a greater affinity than zircone for the fulphuric acid, as well as for the muriatic, likewife decompofe the fulphate of zircone by fuperfluous double attractions. In all thefe cafes muriate of zircone is produced, with the fulphates correfponding in refpect of their bafes to the decompofing muriates.

40, 41, 42, 43, 44, 45, 46, 47.

The eight phofphates of barites, ftrontian, pot-afh, foda, ammonia, magnefia, glucine, and alumine, in a word, all the phofphates, except thofe of lime and zircone, decompofe the zirconian fulphate. The double attractions here are all fuperfluous. In each cafe phofphate of zircone is formed, with fulphates differing according to the fpecies of the decompofing phofphates.

48, 49,

48, 49 50, 51, 52, 53, 54, 55.

It is the fame with the eight following phof-phites; all the phofphites, that of lime excepted, decompofing the fulphate of zircone by fuper-fluous double attractions; a phofphite of zir-cone being always found.

56, 57, 58, 59, 60, 61, 62.

The feven fluates of barites, ftrontian, mag-nefia, pot-afh, foda, ammonia, and glucine, de-compofe the fulphate of zircone by fuperfluous double attractions. That of lime is the only one by which it is not decompofed. In all thefe decompofitions fluate of zircone is pro-duced.

63, 64, 65, 66, 67.

The five borates of barites, ftrontian, pot-afh, foda, and ammonia, decompofe the ful-phate of zircone. The borates of lime and magnefia do not appear capable of acting as the preceding.

We are wholly ignorant of the action of the borates of alumine and glucine, which are yet unknown.

Borate of zircone is uniformly produced in the decompofitions above-mentioned.

68, 69,

68, 69, 70, 71, 72, 73, 74, 75, 76.

The carbonates with bafes of barites, ftrontian, lime, pot-afh, foda, magnefia, ammonia, glucine, and alumine, decompofe the fulphate of zircone by fuperfluous double attractions. In thefe nine decompofitions carbonate of zircone is uniformly produced, with fulphates differing according to the bafes of the carbonates employed to affect them.

XV. SULPHATE OF BARITES.

IT is decompofed by the twenty-feven following, befide the thirteen fulphates already mentioned.

Note. The fulphites will not be again treated with the fulphates, becaufe, thefe having been already examined in the fourteen preceding fpecies, they would here be only repetitions.

1. *Nitrate of Strontian.*

The products are $\begin{cases} \text{nitrate of barites.} \\ \text{fulphite of ftrontian.} \end{cases}$

Neceffary attraction.

2. *Nitrite*

2. *Nitrate of Strontian?*

The products are $\begin{cases} \text{nitrate of barites.} \\ \text{fulphite of ftrontian.} \end{cases}$

Neceſſary attraction.

3. *Muriate of Strontian.*

The products are $\begin{cases} \text{muriate of barites.} \\ \text{fulphite of ftrontian.} \end{cases}$

Neceſſary attraction.

4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.

Of the fourteen ſpecies of phoſphates which I have made known, there are eleven that decompoſe ſulphite of barites. The phoſphates of barites, lime, and ſilex, are the only exceptions. All the double attractions here are ſuperfluous, ſince the phoſphoric acid alone decompoſes all the ſulphites.

Phoſphite of barites is uniformly produced in theſe decompoſitions: the ſulphites formed vary according to the baſes of the phoſphates employed.

The acid phoſphate of lime acts only till its exceſs of acid is abſorbed.

15, 16, 17, 18, 19, 20, 21, 22, 23.

The nine fpecies of phofphites anfwering to the phofphates mentioned above, except the acid calcareous fpecies, that of foda and ammonia, and that of filex, which are not known in this genus as in the phofphates, decompofe the fulphite of barites. Phofphite of barites is formed inftead of phofphate. The attractions are all of the fuperfluous kind.

24. *Fluate of Strontian?*

The products are $\left\{\begin{array}{l}\text{fluate of barites.}\\\text{fulphite of ftrontian.}\end{array}\right.$
Superfluous attraction.

No borate decompofes this falt.
Three carbonates only effect its decompofition; namely,

25. *Carbonate of Pot-Afh.*

The products are $\left\{\begin{array}{l}\text{fulphite of pot-afh.}\\\text{carbonate of barites.}\end{array}\right.$
Neceffary attraction.

26. *Carbonate*

26. *Carbonate of Soda.*

The products are $\begin{cases} \text{fulphite of foda.} \\ \text{carbonate of barites.} \end{cases}$
Neceffary attraction.

27. *Carbonate of Ammonia.*

The products are $\begin{cases} \text{fulphite of ammonia.} \\ \text{carbonate of barites.} \end{cases}$
Neceffary attraction.

XVI. SULPHITE OF LIME.

IT is decompofed by the twenty-five following:

None of the fulphates decompofe it, as we have feen in the fourteen fpecies of this genus treated on above.

No nitrate, or nitrite decompofes it.

No muriate decompofes it.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

Twelve phofphates decompofe the fulphite of lime. There are only that with bafe of lime,
the

the acid calcareous phofphate, and that of filex, by which it is not decompofed.

13, 14, 15, 16, 17, 18.

Six fluates, thofe with bafes of barites, ftrontian, magnefia, pot-afh, foda, ammonia, decompofe the fulphite of lime, and calcareous fulphite is formed.

19. *Borate of Strontian?*

The products are $\begin{cases} \text{borate of lime.} \\ \text{fulphite of ftrontian.} \end{cases}$
Superfluous attraction.

20. *Borate of Magnefia?*

The products are $\begin{cases} \text{fulphite of magnefia.} \\ \text{borate of lime.} \end{cases}$
Neceffary Attraction.

21, 22, 23, 24, 25.

Five carbonates, namely, thofe of barites, ftrontian, pot-afh, foda, and ammonia, decompofe the fulphite of lime, and carbonate of lime is produced. The double attractions are almoft all neceffary. The fulphites formed vary according to the bafes of the carbonates employed to effect the decompofition.

XVII.

XVII. SULPHITE OF POT-ASH.

IT is decompofed by the fifty-three follow-ing, befide the twelve fulphates already men-tioned.

1, 2, 3, 4, 5, 6, 7, 8, 9.

The nitrates of barites, foda, ftrontian, lime, magnefia, ammoniaca-magnefian glucine, alu-mine, and zircone, decompofe the fulphite of pot-afh. Nitrate of pot-afh is uniformly pro-duced by thefe decompofitions, all of which are effected by a fuperfluous attraction, fince the nitric acid is ftronger than the fulphureous.

10, 11, 12, 13, 14, 15, 16, 17, 18.

The nitrites with the fame bafes as the for-going nitrates effect fimilar decompofitions.

19, 20, 21, 22, 23, 24, 25, 26, 27, 28.

Ten muriates, thofe of barites, foda, ftron-tian, lime, ammonia, magnefia, ammoniaco-magnefian, and glucine, decompofe fulphite of potafh. The products are muriate of pot-afh, and different fulphates.

4

29, 30.

29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39.

Nine phofphates decompofe fulphite of lime: there are only thofe of barites, lime, ftrontian, and pot-afh, which do not decompofe it.

40, 41, 42, 43, 44, 45, 46, 47.

Eight phofphites, fimilar to the phofphates with refpect to their bafes, that of foda and ammonia, which is not known, excepted, decompofe the fulphite of pot-afh.

48, 49, 50, 51, 52.

Five fluates, thofe of barites, ftrontian, magnefia, foda, and ammonia, decompofe fulphite of pot-afh. In thefe decompofitions fluate of pot-afh is formed.

No borate is known to decompofe this falt.

53. *Carbonate of Soda.*

The products are $\begin{cases} \text{carbonate of pot-afh.} \\ \text{fulphite of foda.} \end{cases}$

Neceffary attraction.

XVIII.

XVIII. Sulphite of Soda.

IT is decompofed by the forty-five following, befide the twelve fulphates already mentioned.

1, 2, 3, 4, 5, 6, 7, 8.

Eight nitrates, namely, thofe with bafes of barites, ftrontian, lime, magnefia, ammoniaco-magnefian glucine, alumine, and zircone, decompofe the fulphite of foda. Nitrate of foda is produced in all thefe decompofitions, which are effected by a fuperfluous attraction.

9, 10, 11, 12, 13, 14, 15, 16.

The eight nitrites, with the fame bafes as the preceding nitrates, decompofe fulphite of foda in a fimilar manner.

17, 18, 19, 20, 21, 22, 23, 24, 25.

All the muriates, except thofe of pot-afh, foda, and filex, decompofe the fulphite of foda by fuperfluous attraction ; uniformly producing muriate of foda, and fulphites with bafes correfponding to the muriates employed.

26, 27,

26, 27, 28, 29, 30, 31, 32.

The feven phofphates, with bafes of lime, magnefia, ammonia, ammoniaco-magnefian glucine, alumine, and zircone, decompofe the fulphite of foda by fuperfluous attraction, and phofphate of foda is conftantly formed.

33, 34, 35, 36, 37, 38, 39.

I place here the feven phofphites, with bafes correfponding to the preceding phofphates, as decompofing the fulphite of foda.

40, 41, 42, 43.

There are four fpecies of fulphates, namely, thofe with bafe of barites, ftrontian, magnefia, and ammonia, which decompofe the fulphite of foda.

44. *Borate of Pot-Afh.*

The products are $\begin{cases} \text{fulphite of pot-afh.} \\ \text{borate of foda.} \end{cases}$
Superfluous attraction.

45. *Carbonate of Pot-Afh.*

The products are $\begin{cases} \text{fulphite of pot-afh.} \\ \text{carbonate of foda.} \end{cases}$
Superfluous attraction.

XIX.

XIX. SULPHITE OF STRONTIAN.

IT is decompofed by the thirty-three follow-
ing, befide the nine fulphates already noticed.

1. *Nitrate of Lime.*

The products are $\begin{cases} \text{nitrate of ftrontian.} \\ \text{fulphite of lime.} \end{cases}$
Superfluous attraction.

2. *Nitrate of Magnefia.*

The products are $\begin{cases} \text{nitrate of ftrontian.} \\ \text{fulphite of magnefia.} \end{cases}$
Superfluous attraction.

3. *Nitrate of Alumine.*

The products are $\begin{cases} \text{nitrate of ftrontian.} \\ \text{fulphite of alumine.} \end{cases}$
Superfluous attraction.

4. *Nitrate of Zircone.*

The products are $\begin{cases} \text{nitrate of ftrontian.} \\ \text{fulphite of zircone.} \end{cases}$
Superfluous attraction.

5, 6, 7, 8.

The four nitrites, with the fame bafes as the preceding nitrates, act like them. The products are nitrite of ftrontian with the different fulphites.

9. *Muriate of Lime?*

The products are $\begin{cases} \text{muriate of ftrontian.} \\ \text{fulphite of lime.} \end{cases}$

Superfluous attraction.

10. *Muriate of Alumine.*

The products are $\begin{cases} \text{muriate of ftrontian.} \\ \text{fulphite of alumine.} \end{cases}$

Superfluous attraction.

11. *Muriate of Zircone.*

The products are $\begin{cases} \text{muriate of ftrontian.} \\ \text{fulphite of zircone.} \end{cases}$

12, 13, 14, 15, 16, 17, 18, 19, 20.

Nine phofphates, the acid phofphate of lime, and the phofphates of pot-afh, foda, ammonia, foda and ammonia, ammoniaco-magnefian, and of glucine, alumine, and zircone, decompofe the

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fulphite of ftrontian. The products are phofphate of ftrontian and the different fulphites. The double attractions are all fuperfluous on account of the feeblenefs of the fulphureous acid.

21, 22, 23, 24, 25, 26, 27, 28.

The eight phofphites, with the fame bafes as the preceding, except that of foda and ammonia, which is not known, decompofe the fulphite of ftrontian in the fame manner as the phofphates.

We are entirely ignorant of the action of fluates on this falt.

No borate is known to be capable of decompofing it.

29, 30, 31, 32, 33.

Five carbonates appear capable of effecting its decompofition, namely, the carbonates of barites, lime, pot-afh, foda, and ammonia. In all thefe cafes carbonate of ftrontian is formed. The double attraction is neceffary for the carbonates of lime and ammonia; fuperfluous for thofe of barites, pot-afh, and foda.

XX. Sulphite of Ammonia.

IT is decompofed by the forty three follow-ing, befides the five fulphates already mentioned.

1, 2, 3, 4, 5, 6, 7, 8.

There are eight nitrates which decompofe the fulphite of ammonia, namely, the nitrates of barites, ftrontian, lime, magnefia, ammoniaco-magnefian, glucine, alumine, and zircone. The products are nitrates of ammonia, and fulphites, varying according to the bafes of the decom-pofing nitrates. The attractions are all of the fuperfluous kind.

9, 10, 11, 12, 13, 14, 15, 16.

The eight nitrites, with the fame bafes as the preceding nitrates, act like them on the ammo-niacal fulphite.

17, 18, 19, 20, 21, 22, 23, 24.

Eight muriates; thofe with bafes of barites, ftrontian, lime, magnefia, ammoniaco-magne-fian, glucine, alumine, and zircone, decompofe the fulphite of ammonia. The products of thefe fuperfluous double attractions are muriate of ammonia, and the different fulphites.

25, 26,

25, 26, 27, 28.

Only four phofphates, the acid phofphate of lime, and the phofphates of glucine, alumine, and zircone, decompofe the fulphite of ammonia.

29, 30, 31, 32.

The four phofphites, with the fame bafes, equally effect the decompofition of the ammoniacal fulphite.

33, 34, 35.

Three fluates, namely, thofe of barites, ftrontian, and magnefia, appear to decompofe the fulphite of ammonia.

36, 37, 38, 39, 40.

Five borates, thofe of barites, ftrontian, magnefia, pot-afh, and foda, decompofe the fulphite of ammonia.

41, 42, 43.

Three carbonates only, thofe of barites, pot-afh, and foda, are capable of decompofing the the fulphite of ammonia.

XXI. SULPHITE

XXI. Sulphite of Magnesia.

IT is decompofed by the forty-two following, befide the five fulphates already mentioned.

1, 2, 3, 4, 5.

The five nitrates of barites, lime, glucine, alumine, and zircone, decompofe the fulphite of magnefia by fuperfluous attractions. The products are nitrates of magnefia, and the different fulphates.

6, 7, 8, 9, 10.

The five nitrites, with the fame bafes as the preceding nitrates, appear equally to decompofe the fulphite of magnefia.

11, 12, 12, 14.

Four muriates, thofe of barites? lime? alumine, and zircone? appear to be capable of decompofing fulphite of magnefia.

15, 16, 17, 18, 19, 20, 21, 22.

Eight fpecies of phofphates, the acid phofphate of lime, and the phofphates of pot-afh, foda, ammonia, ammoniaco-magnefian, glucine,

cine, alumine, and zircone, appear to decom-
pofe the fulphite of magnefia.

23, 24, 25, 26, 27, 28, 29, 30.

It is probable, that the eight phofphites, with
the fame bafes as the preceding phofphates,
likewife decompofe this falt.

31. *Fluate of Barites?*

The products are $\begin{cases} \text{fluate of magnefia.} \\ \text{fulphite of barites.} \end{cases}$
Superfluous attraction.

32. *Fluate of Strontian.*

The products are $\begin{cases} \text{fluate of magnefia.} \\ \text{fulphite of ftrontian.} \end{cases}$
Superfluous attraction.

33, 34, 35, 36.

Four borates, thofe of ftrontian, pot-afh,
foda, and ammonia, decompofe the fulphite of
magnefia.

37, 38, 39, 40, 41, 42.

Six carbonates, thofe of barites, ftrontian,
lime, pot-afh, foda, and ammonia, decompofe
the

the fulphite of magnefia, almoft all by fuper-
fluous attraction. The products are carbonate
of magnefia, and the different fulphites.

———

XXII. AMMONIACO-MAGNESIAN SULPHITE.

IT is decompofed by the forty-eight follow-
ing, befide the five fulphates already noticed.

1, 2, 3, 4, 5, 6, 7.

The feven nitrates of barites, ftrontian, lime,
magnefia, glucine, alumine, and zircone, de-
compofe the ammoniaco-magnefian fulphite.
The products are triple nitrate, and the dif-
ferent fulphites.

8, 9, 10, 11, 12, 13, 14.

The feven nitrites with the fame bafes as the
preceding nitrates, decompofe the ammoniaco-
magnefian fulphite in a fimilar manner. The
products are a triple nitrite, and fulphites of
different bafes according to the nitrites em-
ployed.

15, 16,

15, 16, 17, 18, 19, 20,

Six muriates, thofe of barites, ftrontian, lime, glucine, alumine, and zircone, decompofe the ammoniaco-magnefian fulphite. The products are triple muriate, and fulphites varying according to the nature of the muriates ufed.

21, 22, 23, 24, 25, 26, 27.

Seven phofphates; namely, the acid phofphate of lime, and the phofphates which have for their bafe pot-afh, foda, ammonia, glucine, alumine, or zircone, decompofe the ammoniaco-magnefian fulphite. The products are a triple phofphate, and fulphites differing according to the bafes of the phofphates employed for the decompofition.

28, 29, 30, 31, 32, 33, 34.

The feven phofphites, with the fame bafes as the preceding phofphates equally decompofe the ammoniaco-magnefian fulphite. The refults are a triple phofphite, and the different fulphites.

35, 36,

35, 36, 37.

Three fluates, thofe of barites, ftrontian, and magnefia, decompofe the ammoniaco-magnefian fulphite. The products are a fluate with the double bafe, and three different fulphites.

38, 39, 40, 41, 42.

Five borates, thofe with bafes of ftrontian, magnefia, pot-afh, foda, and ammonia, decompofe this triple fulphite.

43, 44, 45, 46, 47, 48.

The fix carbonates of barites, ftrontian, lime, pot-afh, foda, and ammonia, decompofe the ammoniaco-magnefian fulphite. The refults are carbonate of magnefia and ammonia, and fulphites differing according to the bafes of the carbonates employed for the decompofition.

XXIII

XXIII. SULPHITE OF GLUCINE.

IT is decompofed by the thirty-feven following. Befides the four fulphates already mentioned,

1, 2, 3, 4.

The four nitrates of barites, lime, alumine, and zircone, decompofe the fulphite of glucine. They produce a nitrate with the laft mentioned bafe, and four different fulphites.

5, 6, 7, 8.

The four nitrites with the fame bafes as the preceding nitrates decompofe the fulphite of glucine.

9, 10, 11, 12, 13.

The five muriates of barites, ftrontian, lime, alumine, and zircone, decompofe the fulphite of glucine; forming a muriate with the laft mentioned bafe, and different fulphites.

14, 15,

14, 15, 16, 17, 18, 19.

Six phofphates, the acid phofphate of lime, and the phofphates of pot-afh, foda, ammonia, alumine, and zircone, decompofe the fulphite of glucine.

20, 21, 22, 23, 24, 25.

The fix phofphites, with the fame bafes as the preceding phofphates likewife decompofe the fulphite of glucine. They form a phof‑phite with this bafe, inftead of a phofphate.

26. *Fluate of Barites.*

The products are { fluate of glucine.
{ fulphite of barites.
Superfluous attraction.

27. *Fluate of Strontian.*

The products are { fluate of glucine.
{ fulphite of ftrontian.
Superfluous attraction.

28, 29, 30.

The three borates of ftrontian, magnefia, and ammonia, decompofe the fulphite of glucine.

31, 32, 33, 34, 35, 36, 37.

The feven carbonates of barites, ftrontian, lime, pot-afh, foda, magnefia, and ammonia, decompofe the fulphite of glucine.

———

XXIV. Sulphite of Alumine.

IT is decompofed by the twenty-four following, befide the fulphate of zircone already mentioned.

1. *Nitrate of Barites.*

The products are $\begin{cases} \text{nitrate of alumine.} \\ \text{fulphite of barites,} \end{cases}$
Superfluous attraction.

2. *Nitrate*

2. *Nitrate of Lime.*

The products are $\left\{\begin{array}{l}\text{nitrate of alumine.}\\ \text{fulphite of lime.}\end{array}\right.$
Superfluous attraction.

3. *Nitrate of Zircone.*

The products are $\left\{\begin{array}{l}\text{nitrate of alumine.}\\ \text{fulphite of zircone.}\end{array}\right.$
Neceffary attraction.

4, 5, 6.

The three *nitrites*, of barites, lime, and zir-cone, decompofe the fulphite of alumine in like manner as the preceding nitrates.

7, 8, 9.

The muriates of barites, lime, and zircone, decompofe the fulphite of alumine. The pro-ducts are muriate of alumine, and the different fulphites.

10, 11.

There are but two phofphates, the acid phof-phate of lime, and the phofphate of zircone, which

which are capable of decompofing the fulphite of alumine.

12, 13.

The two phofphites with the fame bafes probably effect a fimilar decompofition of this falt.

We are not acquainted with any action of the fluates, on the fulphite of alumine.

14, 15, 16.

There is reafon to believe, that the borates of barites, ftrontian, and magnefia, decompofe the fulphite of alumine.

17, 18, 19, 20, 21, 22, 23, 24.

The eight carbonates of barites, ftrontian, lime, pot-afh, foda, magnefia, ammonia, and glucine, decompofe the fulphite of alumine. The products are carbonate of alumine, and the refpective fulphites.

XXV.

XXV. Sulphite of Zircone.

IT is decompofed by the 15 following.

1, 2. *Nitrates of Barites, and of Lime.*

The products are $\left\{\begin{array}{l} \text{nitrate of zircone.} \\ \text{fulphite of barites, or of} \\ \text{lime.} \end{array}\right.$

Superfluous attraction.

3, 4. *Nitrites of Barites, and of Lime.*

The products are $\left\{\begin{array}{l} \text{nitrite of zircone.} \\ \text{fulphite of barites, or of} \\ \text{lime.} \end{array}\right.$

Superfluous attraction.

5, 6, 7.

Muriates of barites, ftrontian, and lime.
Superfluous attraction.

The products are muriate of zircone, and ful-
phites of barites, ftrontian, or lime.

We are unacquainted with the action of the
phofphates, on the fulphite of zircone, as well
as with that of the phofphites.

3   We

We are equally ignorant of the double de-compofitions effected on the fulphite of zircone by the fluates and the borates.

8, 9, 10, 11, 12, 13, 14, 15.

The eight carbonates of barites, ftrontian, lime, pot-afh, foda, magnefia, ammonia, and glucine, decompofe the fulphite of zircone. The products are carbonate of zircone, and ful-phites, varying according to the nature of the decompofing carbonates.

XXVI. NITRATE OF BARITES.

Note. The action of the nitrates on the ni-trites is abfolutely unknown.

Action of the muriates : equally unknown.

We are ignorant of the action of the fuper-oxigenated muriates on this falt, which is de-compofed by the twelve following. Befides the twenty fulphates or fulphites already noticed.

1, 2, 3.

Phofphates of pot-afh, foda, and ammonia. *Neceffary attraction.* The products are phof-phate of barites, and different nitrates.

2   The

The phofphites appear to have nearly the fame action as the phofphates.

4, 5, 6.

Among the fluates there are only thofe of pot-afh, foda, and ammonia, which appear to occafion any change in it: but their decompofing it is yet doubtful.

7, 8, 9.

Borates of pot-afh, foda, and ammonia. *Neceffary attraction.* The products are borate of barites, and nitrate with the different bafes.

10, 11, 12.

The carbonates of pot-afh, foda, and ammonia decompofe it by *neceffary attraction*, and produce carbonate of barites, and nitrates of pot-afh, foda, and ammonia.

———

XXVII. Nitrate of Pot-ash.

IT is decompofed by the following fpecies. Befide the nine fulphates or fulphites already noticed.

T

1. *Muriate of Barites.*

The products are $\begin{cases} \text{muriate of pot-aſh.} \\ \text{nitrate of barites.} \end{cases}$

Superfluous attraction.

Action of the oxigenated muriates, un-known.

That of the phoſphates, phoſphites, fluates, borates, and carbonates, null, or little known.

XXVIII. NITRATE of SODA.

IT is decompoſed by the ſix following. Be-ſide the nine ſulphates or ſulphites noticed above.

1, 2. *Muriates of Barites, and of Pot-Aſh.*

The products are $\begin{cases} \text{muriate of Soda.} \\ \text{nitrate of barites, or of} \\ \text{pot-aſh.} \end{cases}$

Superfluous attraction.

We are unacquainted with the action of the ſuper-oxigenated muriates, on the nitrate of ſoda.

3. The

3. The phofphate of pot-afh decompofes it.

The products are $\begin{cases} \text{phofphate of foda.} \\ \text{nitrate of pot-afh.} \end{cases}$

Superfluous attraction.

The action of the phofphites is nearly the fame as that of the phofphates.

4. *Fluate of Pot-Afh.*

The products are $\begin{cases} \text{fluate of foda.} \\ \text{nitrate of pot-afh.} \end{cases}$

Superfluous attraction.

5. *Borate of Pot-Afh.*

The products are $\begin{cases} \text{borate of foda.} \\ \text{nitrate of pot-afh.} \end{cases}$

Superfluous attraction.

6. *Carbonate of Pot-Afh.*

The fame action.

The products are $\begin{cases} \text{carbonate of foda.} \\ \text{nitrate of pot-afh.} \end{cases}$

Superfluous attraction.

XXIX. NITRATE OF STRONTIAN.

IT is decompofed by the feventeen following, befide the fourteen fulphates or fulphites already mentioned.

1, 2, 3.

Muriates of barites, pot-afh, and foda. *Superfluous attraction.*

The products are, muriate of ftrontian, and nitrates of barites, pot-afh, and foda.

The action of the oxigenated muriates unknown.

4, 5, 6, 7.

The phofphates of barites, pot-afh, foda, and ammonia, decompofe it, forming phofphate of ftrontian, and the different nitrates.

(4, 5, 6, by *fuperfluous attraction*; 7, by *neceffary attraction*.)

8.

The phofphate of foda and ammonia appears capable of decompofing the nitrate of ftrontian, as either of the two falts that compofe it would?

The action of the phofphites fimilar to that of the phofphates.

9. *Fluate*

9. *Fluate of Pot-Afh.*

THIS decompofition is probable.

10, 11.

The fluates of foda, and of ammonia, decompofe the nitrate of ftrontian, forming fluate of ftrontian, and nitrates of foda and ammonia.

12, 13, 14.

The borates of pot-afh, foda, and ammonia, decompofe it as above; 12 and 13 by *fuperfluous*, 14 by *neceffary attraction*. The products are borate of ftrontian, and nitrates, with the different bafes.

15, 16, 17.

Carbonates of barites, pot-afh, and foda. *Superfluous attraction.*
The products are carbonate of ftrontian, and nitrate of barites, pot-afh, or foda, according to the decompofing carbonate employed.

XXX.

XXX. NITRATE OF LIME.

It is decompofed by the twenty-five following, befide the eight fulphates and nine fulphites mentioned above.

1, 2, 3, 4.

The muriates of barites, pot-afh, foda, and ftrontian, decompofe it by fuperfluous attraction, producing muriate of lime and different nitrates.

The action of the oxigenated muriates is unknown.

5, 6, 7, 8, 9,

The phofphates of barites, ftrontian, pot-afh, foda, and ammonia, equally decompofe it, the laft by *neceffary attraction*, all the reft by *superfluous*, producing phofphate of lime and the different nitrates.

10.

The phofphate of magnefia appears to be capable of decompofing nitrate of lime, and

The products muft be $\begin{cases} \text{phofphate of lime.} \\ \text{muriate of magnefia.} \end{cases}$

The phofphites have the fame action as the phofphates on the nitrate of lime.

11. The

11.

The fluate of barites appears to decompofe it.

12.

The fluate of ftrontian decompofes nitrate of lime.

The products are $\begin{cases} \text{fluate of lime.} \\ \text{nitrate of ftrontian.} \end{cases}$

Superfluous attraction.

13.

Fluate of magnefia : this decompofition doubtful, as well as that of fluate of barites ?

14, 15, 16.

The fluates of pot-afh, foda, and ammonia, decompofe it.

The products are $\begin{cases} \text{fluate of lime,} \\ \text{nitrate of pot-afh, of foda,} \\ \text{or of ammonia.} \end{cases}$

17, 18, 19, 20, 21.

The borates of barites, ftrontian, pot-afh, foda, an. ammonia, decompofe it, affording as the
refults

refults borate of lime, and nitrate of barites, ftrontian, pot-afh, foda, or ammonia.

<div align="center">22, 23, 24, 25.</div>

The carbonates of barites, ftrontian, pot-afh, and foda, decompofe the nitrate of lime, and the products are carbonate of lime, and nitrates, with the different bafes.

XXXI. NITRATE OF AMMONIA.

It is decompofed by the fourteen following, befide the four fulphates or fulphites already mentioned.

<div align="center">1, 2, 3, 4, 5.</div>

The muriates of barites, pot-afh, foda, ftrontian, and lime, decompofe the nitrate of ammonia by *fuperfluous attraction*. The products are muriate of ammonia, and nitrates, differing according to the muriate employed.

The action of the fuper-oxigenated muriates is unknown.

<div align="center">6, 7.</div>

The phofphate of pot-afh and of foda.

The products are { phofphate of ammonia, nitrate of pot-afh, or of foda.

Superfluous attraction.

<div align="right">The</div>

The action of the phofphites is nearly fimilar to that of the phofphates.

8, 9.

The fluates of pot-afh and foda decompofe it.

The products are $\begin{cases} \text{fluate of ammonia.} \\ \text{nitrate of pot-afh, or of foda.} \end{cases}$

Superfluous attraction.

10, 11, 12.

The borates of pot-afh and foda, and the fuper-faturated borate of foda, decompofe it.

The products are $\begin{cases} \text{borate of ammonia.} \\ \text{nitrate of pot-afh, or of foda.} \end{cases}$

13, 14.

The carbonates of pot-afh and foda decompofe the nitrate of ammonia by *fuperfluous attraction.*

The products are $\begin{cases} \text{carbonate of ammonia.} \\ \text{nitrate of pot-afh, or of foda.} \end{cases}$

XXXIII.

XXXIII. NITRATE OF MAGNESIA.

IT is decompofed by the twenty-one following, befide the nine fulphates or fulphites previoufly mentioned.

1, 2, 3, 4, 5.

The muriates of barites, pot-afh, foda, ftrontian, and lime, decompofe the nitrate of magnefia by *fuperfluous attraction*. The products of this decompofition are muriate of magnefia, and the nitrates with the different bafes.

6. *Muriate of Ammonia.*

IN the action of this falt on the nitrate of magnefia there is a reciprocal divifion of bafes, and we obtain two triple falts,

called $\begin{cases} \text{muriate of ammonia and magnefia.} \\ \text{nitrate of ammonia and magnefia.} \end{cases}$

The action of the oxigenated muriates is unknown.

7.

The phofphate of barites feems to decompofe the nitrate of magnefia?

8.

It is the fame with the action of phofphate of ftrontian?

9, 10,

9, 10, 11.

The phofphates of pot-afh, foda, and ammonia, decompofe the nitrate of magnefia by *fuperfluous attraction*. The products are phofphate of magnefia, and the refpective nitrates; with this difference, that the phofphate of ammonia muft act here as in No. 6, and form two triple falts, or *trifules*.

The phofphites act perceptibly as the phofphates on the nitrate of magnefia.

12.

The fluate of barites decompofes it by *fuperfluous attraction*. The refults are nitrate of barites and fluate of magnefia.

13.

The decompofition of this falt by fluate of ftrontian is only taken for granted?

14, 15, 16.

The fluates of pot-afh, foda, and ammonia, decompofe the nitrate of magnefia by *fuperfluous attraction*, forming fluate of magnefia, and the refpective nitrates.

7.

The borate of ftrontian apparently ought to decompofe it?

18, 19.

The borates of pot-afh and foda decompofe it, and nitrates of pot-afh and foda are formed.

20, 21.

The carbonates of pot-afh and foda decompofe the nitrate of magnefia by *fuperfluous attraction.* The products are carbonate of magnefia, and nitrates of pot-afh and foda.

XXXIII. Ammoniaco-magnesian Nitrate.

IT is decompofed by the twenty-one following, befide the feven fulphates or fulphites already mentioned.

1, 2, 3, 4, 5.

The muriates of barites, pot-afh, foda, ftrontian, and lime, decompofe it by *fuperfluous attraction.*

3

traction, producing the triple muriate of ammonia and magnesia, and nitrate of barites, potash, soda, strontian, or lime, according to the salt employed.

6.

Muriate of ammonia. It appears that the action of this is confined to a reciprocal division of the bases.

The action of the oxigenated muriates is unknown.

7.

Phosphate of barites. The presence of this salt determines the decomposition of the ammoniaco-magnesian nitrate solely on account of the magnesia. The products are nitrate of barites, and ammoniaco-magnesian phosphate.

8, 9.

The phosphates of pot-ash and soda totally decompose the ammoniaco-magnesian nitrate, and the results must be nitrates of pot-ash and soda, and ammoniaco-magnesian phosphate?

10.

The phosphate of ammonia decomposes this salt only with respect to the magnesia; so that
after

after its action nitrate of ammonia and phofphate of magnefia fhould remain.

The action of he phofphites is nearly fimilar to that of the phofphates.

11, 12.

The fluates of barites and ftrontian decompofe this falt on account of its portion of magnefia folely, and the refults are nitrate of barites, or of ftrontian, and a triple fluate.

13, 14, 15.

The fluates of pot-afh, foda, and ammonia, decompofe this falt by *fuperfluous attraction*, forming a triple fluate, and nitrate of pot-afh, foda, or ammonia.

16.

The borate of ftrontian decompofes the ammoniaco-magnefian nitrate with refpect to the magnefia only. The products are nitrate of ftrontian, and a triple borate of ammonia and magnefia.

17, 18, 19.

The borates of pot-afh, foda, and ammonia, decompofe the ammoniaco-magnefian nitrate, producing a triple borate, and different nitrates.

20, 21,

20, 21.

The carbonates of pot-afh and foda decompofe it by *fuperfluous attraction*, producing a triple carbonate, and nitrate of pot-afh, or of foda.

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XXXIV. Nitrate of Glucine.

IT is decompofed by the twenty following, befide the five fulphates or fulphites already noticed.

1, 2, 3, 4, 5, 6.

The muriates of barites, pot-afh, foda, ftrontian, lime, and ammonia, decompofe the nitrate of glucine by *fuperfluous attraction*. The products are muriate of glucine, and the nitrates of the refpective bafes.

The action of the fuper-oxigenated muriates on the nitrate of glucine is unknown.

7.

The phofphate of barites appears to decompofe the nitrate of glucine, and the refults muft be phofphate of glucine and nitrate of barites?

8, 9,

8, 9, 10.

The phofphates of pot-afh, foda, and ammonia, decompofe it by *fuperfluous attraction*, producing phofphate of glucine and the refpective nitrates.

11.

Phofphate of magnefia. This decompofition taken for granted?

The action of the phofphites is nearly fimilar to that of the phofphates.

12, 13, 14.

The fluates of pot-afh, foda, and ammonia, decompofe nitrate of glucine by *fuperfluous attraction*. The products are fluate of glucine, and the different nitrates.

15, 16, 17.

The borates of pot-afh, foda, and ammonia, act on this falt like the three preceding. The products are borate of glucine, and the refpective nitrates.

18, 19, 20.

The carbonates of pot-afh, and magnefia, decompofe the nitrate of glucine by *fuperfluous attraction*.

attraction. The products are carbonate of glu-
cine, and nitrate of pot-ash, foda, or mag-
nefia.

XXXV. NITRATE OF ALUMINE.

IT is decompofed by the twenty-three follow-
ing, befide the eight fulphates or fulphites al-
ready mentioned.

1, 2, 3, 4, 5, 6, 7.

The muriates of barites, pot-afh, foda, ftron-
tian, lime, ammonia, and glucine, decompofe
the nitrate of alumine by *fuperfluous attraction* ;
producing muriate of alumine, and the various
nitrates.

The action of the oxigenated muriates is un-
known.

8, 9.

The phofphates of barites and ftrontian de-
compofe the nitrate of alumine, and produce
phofphate of alumine, and nitrate of barites or
ftrontian : *fuppofed ?*

10.

The phofphate of magnefia appears to act in the fame manner?

11, 12, 13.

The phofphates of pot-afh, foda, ammonia, and glucine, decompofe it: the products are phofphate of alumine, and the refpective nitrates.

14, 15, 16.

The fluates of pot-afh, foda, and ammonia, decompofe nitrate of alumine by *fuperfluous attraction*. The products are fluate of alumine, and nitrate of pot-afh, foda, or ammonia.

17, 18, 19.

The borates of pot-afh, foda, and ammonia, act on this falt like the preceding, the products being borate of alumine, and different nitrates.

20, 21, 22, 23.

The carbonates of pot-afh, foda, magnefia, and glucine, decompofe the nitrate of alumine, producing

4

producing carbonate of alumine, and nitrates with the feveral bafes.

———

XXXVI. Nitrate of Zircone.

IT is decompofed by the twenty-feven following, befide the eight *fulphites* already mentioned : *(fulphates* 0.*)*

1, 2, 3, 4, 5, 6, 7, 8.

The muriates of barites, pot-afh, foda, ftrontian, lime, ammonia, glucine, and alumine, decompofe it by *fuperfluous attraction.* The products are muriate of zircone, and the different nitrates.

The action of the oxigenated muriates is unknown.

9, 10.

The phofphates of barites and ftrontian appear to decompofe it; and the refults muft be phofphate of zircone, and nitrate of barites or ftrontian.

11, 12, 13, 14, 15, 16.

The phofphates of pot-afh, foda, ammonia, magnefia, glucine, and alumine, decompofe the

nitrate

nitrate of zircone by *superfluous attraction.* The products are phofphate of zircone, and the different nitrates.

The action of the phofphites is nearly fimilar to that of the phofphates.

17, 18, 19.

The fluates of pot-afh, foda, and ammonia, decompofe the nitrate of zircone. The products are fluate of zircone, and nitrate of pot-afh, foda, or ammonia.

20, 21, 22.

The borates of pot-afh, foda, and ammonia, act on this falt like the preceding, the refults only differing, being on the one hand borate of zircone, on the other nitrate of pot-afh, foda, or ammonia.

23, 24, 25, 26, 27.

The carbonates of pot-afh, foda, magnefia, glucine, and alumine, decompofe this falt. The products are carbonate of zircone, and the different nitrates.

XXXVII.

XXXVII. to XLVII. Inclusively. NITRITES.

THE action of the other salts on the nitrites is too little known, to be determined here with accuracy.

XLVIII. MURIATE OF BARITES.

IT is decomposed by the ten following, beside the thirteen *sulphates*, eight *sulphites*, and ten *nitrates*, already mentioned.

The action of the oxigenated muriates or muriate of barites is unknown.

1, 2, 3.

The phosphates of pot-afh, foda, and ammonia, are decomposed by the muriate of barites: the products are phosphate of barites, and muriate of pot-afh, foda, or ammonia. *Neceffary attraction.*

The phosphites act nearly as the phosphates.

No fluate is capable of decomposing the muriate of barites.

4, 5.

4, 5, 6, 7.

The borates of pot-afh, of foda, fuperfaturated with foda, and ammonia, decompofe the muriate with barites: the refults are borate of barites, and phofphate of pot-afh, foda, and ammonia. *Neceffary attraction.*

8, 9, 10.

The carbonates of pot-afh, foda, and ammonia, likewife decompofe it by *Neceffary attraction.*

XLIX. MURIATE OF POT-ASH.

IT is decompofed by the following, befide the fix fulphates, and nine nitrates, already mentioned.

The action of the oxigenated muriates 0.

The phofphates and phofphites have no action on the muriate of pot-afh.

1.

The fluate of barites decompofes the muriate of pot-afh by *fuperfluous attraction.* The pro-
-ducts

ducts are fluate of pot-afh, and muriate of barites.

The action of the carbonates on this falt appears to be null, as well as that of the borates.

L. MURIATE OF SODA.

IT is decompofed by the fix following, befide the eight *fulphates* or *fulphites*, and the eight *nitrates*, already mentioned.

The action of the oxigenated muriates, 0.

1.

The phofphate of pot-afh decompofes the muriate of foda by *fuperfluous attraction.*

The phofphites act like the phofphates on this falt.

2, 3.

The fluates of barites and pot-afh decompofe the muriate of foda by *fuperfluous attraction.* The refults are fluate of foda, and muriate of barites, and of pot-afh.

4.

The fluate of ammonia appears to decompofe the muriate of foda; producing, by *neceffary attraction*, fluate of foda and muriate of ammonia?

5. *Borate of Pot-Afh.*

The products are $\begin{cases} \text{borate of foda.} \\ \text{muriate of pot-afh.} \end{cases}$
Neceffary attraction.

6. *Carbonate of Pot-Afh.*

The products are $\begin{cases} \text{carbonate of foda.} \\ \text{muriate of pot-afh.} \end{cases}$
Neceffary attraction.

LI. MURIATE OF STRONTIAN.

IT is decompofed by the fifteen following, befide the ten *fulphates*, feven *fulphites*, and feven *nitrates*, already mentioned.

The action of the oxigenated muriates 0.

1.

1,

The phofphate of barites decompofes the mu-
riate of ftrontian by *fuperfluous attraction.* The
products are phofphate of ftrontian, and muri-
ate of barites,

2, 3, 4.

The phofphates of pot-afh, foda, and am-
monia decompofe it : for the firft and fecond,
the double attraction is *fuperfluous,* for the
third *neceffary.* The refults are phofphate of
ftrontian, and the various muriates.

The phofphites act like the phofphates.

5.

The phofphate of barites apparently decom-
pofes the muriate of ftrontian : the products are
phofphate of ftrontian, and muriate of barites?

6, 7.

The fluates of pot-afh and of foda, though
little known as to their mode of decompofition
with muriate of ftrontian, apparently decom-
pofe it?

8, 9,

8, 9, 10, 11.

The borates of pot-afh, foda, fuperfaturated with foda, and ammonia, decompofe the muriate of ftrontian; and the decompofition furnifhes borate of ftrontian, and different muriates.

12.

The carbonate of barites apparently decompofes this falt?

13, 14, 15.

The carbonates of pot-afh, foda, and ammonia, decompofe the muriate of ftrontian: the products are carbonate of ftrontian, and the different muriates.

LII. MURIATE OF LIME.

IT is decompofed by the twenty-three following, befide the eight *fulphates*, nine *fulphites*, and fix *nitrates*, already mentioned.

The action of the oxigenated muriates, 0.

1, 2, 3, 4, 5.

The phofphates of barites, ftrontian, pot-afh, foda, and ammonia, decompofe the muriate of lime:

lime : the products are phofphate of lime, and muriate of barites, ftrontian, pot-afh, or foda, or ammonia.

6.

The phofphate of magnefia apparently decompofes this falt?

The action of the phofphites is nearly fimilar to that of the phofphates.

7 8, 9, 10, 11, 12.

The fluates of barites ftrontian, magnefia, pot-afh, foda, and ammonia, decompofe the muriate of lime : the products are fluate of lime, and muriates, varying according to the decompofing fluate.

13, 14, 15, 16, 17, 18.

The borates of barites, ftrontian, pot-afh, foda, and ammonia, decompofe the muriate of lime by *fuperfluous attraction*. The products are borate of lime, and muriates with different bafes.

19, 20.

The carbonates of barites and ftrontian, apparently decompofe the muriate of lime?

21, 22,

21, 22, 23.

The carbonates of pot-afh, foda, and ammonia, decompofe the muriate of lime, producing carbonate of lime, and different phofphates.

LIII. MURIATE OF AMMONIA.

IT is decompofed by the eleven following, befide the three *fulphates*, two *fulphites*, and two *nitrates*, mentioned above.

The oxigenated muriates 0.

1, 2.

The phofphates of pot-afh, and of foda, decompofe the muriate of ammonia by *fuperfluous attraction*: the products are phofphate of ammonia, and muriates of pot-afh, and of foda.

The phofphites, act like the phofphates on this falt.

3, 4, 5, 6.

The fluates of barites, ftrontian, pot-afh, and foda, decompofe the muriate of ammonia; producing

ducing fluate of ammonia, and different muriates.

7, 8.

The borates of pot-afh, and foda, decompofe the muriate of ammonia.

The products are { borate of ammonia.
muriate of pot-afh, or of foda.

Superfluous attraction.

9, 10.

The carbonates of pot-afh and foda act in a fimilar manner.

The products are { carbonate of ammonia.
muriate of pot-afh, or of foda.

11.

The carbonate of magnefia apparently decompofes the muriate of ammonia, forming two triple falts with the two acids?

———

LIV. MURIATE OF MAGNESIA.

IT is decompofed by the nineteen following, befide the four *fulphates* and the *fulphites* already mentioned.

The

The action of the oxigenated nitrates and muriates 0.

1, 2.

The phofphates of barites and ftrontian may be prefumed to decompofe the muriate of magnefia, by *fuperfluous attraction*; the products of which muft be phofphate of magnefia, and muriate of barites, and ftrontian?

3, 4, 5.

The phofphates of pot-afh. foda, and ammonia, decompofe the muriate of magnefia by fuperfluous attraction : the products are phofphate of magnefia, and the different muriates. The phofphites act like the phofphates.

6, 7.

The fluates of ftrontian and foda, decompofe the muriate of magnefia by *fuperfluous attraction* : the products are fluate of magnefia, and nitrates of foda and ftrontian.

8, 9, 10.

The fluates of barites, pot-afh, and ammonia, apparently muft be capable of decompofing the muriate of magnefia; and the refults will be

be fluate of magnefia, and the different muriates?

11, 12.

The borates of barites, and ftrontian, apparently decompofe the muriate of magnefia?

13, 14, 15, 16.

The borates of pot-afh, foda, fuper-faturated with foda, and ammonia, decompofe the muriate of magnefia; producing borate of magnefia, and different muriates.

17, 18, 19.

The carbonates of pot-afh, foda, and ammonia, decompofe the muriate of magnefia by *fuperfluous attraction*: the products are carbonate of magnefia, and the different muriates.

LV. Ammoniaco-Magnesian Muriate.

IT is decompofed by the nineteen following befide the four *fulphates*, and the four *fulphites*, already mentioned.

The

The action of the nitrates and oxigenated muriates 0.

1, 2, 3.

The phofphates of barites, ftrontian, and ammonia, apparently muft decompofe the ammoniaco-magnefian muriate only with refpect to the magnefia; whence would refult a triple phofphate, and the different muriates of barites, ftrontian, and ammonia.

4, 5.

The phofphates of pot-afh and foda, decompofe it by *fuperfluous attraction*; the products are a triple phofphate, and muriate of pot-afh, and of foda.

The action of the phofphites is fimilar to that of phofphates.

6.

The fluate of barites decompofes the ammoniaco-magnefian muriate only, as it would feem, with refpect to the magnefia?

7, 8, 9.

The fluates of ftrontian, pot-afh, and foda, decompofe it by *fuperfluous attraction*: the products

products are the ammoniaco-magnefian triple fluate, and the refpective muriates.

10.

The fluate of ammonia apparently decompofes it only in part. No doubt the products are a triple fluate, and muriate of ammonia?

11, 12, 13.

The borates of barites, ftrontian, and ammonia, act on this falt as the fluates No. 7, 8, 9.

14.

The magnefio-calcareous borate, though its affinities are little known, apparently effects a fort of decompofition with this falt, from which may refult an ammoniaco-magnefian borate, and a magnefio-calcareous muriate?

15.

The fluate of ammonia decompofes this triple falt in refpect to a little magnefia, and perhaps two triple falts are formed.

16, 17, 18, 19.

The carbonates of pot-afh, foda, and ammonia, decompofe the ammoniaco-magnefian muriate, producing a triple carbonate, and the refpective muriates.

LVI. MURIATE OF GLUCINE.

IT is decompofed by the twenty-four following, befide the five *fulphates* or *fulphites*, and the two *nitrates*, already mentioned.

The oxigenated muriates 0.

1, 2, 3.

The phofphates of barites, ftrontian, and magnefia, decompofe the muriate of glucine by *fuperfluous attraction*; the products are phofphate of glucine, and the refpective muriates?

4, 5, 6.

The phofphates of pot-afh, foda, and ammonia, decompofe this muriate by *fuperfluous attraction* : the products are phofphate of glucine, and the different muriates.

The

The phofphites would appear to act like the preceding.

7, 8, 9, 10, 11, 12.

The fluates of barites, pot-afh, foda, ftrontian, magnefia, and ammonia, decompofe this falt: the products are fluate of glucine, and muriates, differing according to the decompofing falt.

13, 14, 15.

The borates of barites, ftrontian, and magnefia, probably decompofe the muriate of glucine: the refults muft be borate of glucine, and the refpective muriates?

16, 17, 18.

The borates of pot-afh, foda, and ammonia, are decompofed by the muriate of glucine: the refults are borate of glucine, and the different muriates.

19, 20.

The carbonates of lime and magnefia would appear to decompofe the muriate of glucine, producing carbonate of glucine, and the different muriates.

X 2

21, 22, 23, 24.

The carbonates of ftrontian, pot-afh, foda, and ammonia, decompofe the muriate of glucine by *fuperfluous attraction*, producing carbonate of glucine, and the refpective muriates

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LVII. Muriate of Alumine.

IT is decompofed by the twenty-five following, befide the nine *fulphates* or *fulphites*, and the *nitrate*, already mentioned.

Oxigenated muriates 0.

1, 2, 3.

The phofphates of barites, ftrontian, and magnefia, feem to decompofe the muriate of alumine ?

4, 5, 6, 7.

The phofphates of pot-afh, foda, ammonia, and glucine decompofe it: the products are phofphate of alumine, and the refpective muriates.

The action of the phofphites is nearly equal to that of the phofphates.

8, 9,

8, 9, 10, 11, 12, 13.

The fluates of barites, ftrontian, magnefia, pot-afh, foda, and ammonia, decompofe the muriate of alumine, and different muriates are formed.

14, 15.

The borates of barites and ftrontian feem to effect the decompofition of this falt?

16, 17, 18, 19.

The borates of magnefia, pot-afh, foda, and ammonia, decompofe the muriate of alumine by *fuperfluous attraction:* the products are borate of alumine, and the different muriates.

20, 21, 22, 23, 24, 25.

The carbonates of barites, lime, pot-afh, foda, magnefia, and ammonia, decompofe the muriate of alumine, carbonate of alumine, and the different muriates, being formed.

The decompofition by carbonate of barites (20,) feems doubtful, or is only prefumed?

LVIII.

LVIII. Muriate of Zircone.

IT is decompofed by the twenty-fix following, befide the feven *fulphites* already mentioned.

Sulphates, nitrates, and oxigenated muriates, 0.

1, 2, 3, 4, 5, 6, 7, 8.

The phofphates of barites, ftrontian, pot-afh, foda, ammonia, magnefia, glucine, and alumine, decompofe the muriate of zircone. The refults are phofphate of zircone, and muriates differing according to the decompofing falt.

The phofphites exert on muriate of zircone an action analogous to that of the phofphates.

9, 10, 11, 12, 13, 14.

The fluate of barites, ftrontian, magnefia, pot-afh, foda, and ammonia, decompofe the muriate of zircone: the products are fluate of zircone, and very different muriates.

15, 16.

The borates of barites and ftrontian feem to decompofe it?

17, 18,

17, 18, 19, 20.

The borates of magnefia, pot-afh, foda, and ammonia, decompofe it, producing borate of zircone, and the different muriates.

21.

The carbonate of barites is prefumed to de-compofe it ?

22, 23, 24, 25, 26.

The carbonates of lime, pot-afh, foda, mag-nefia, and ammonia, decompofe it.

———

LIX. Muriate of Silex.

IT is decompofed by the eighteen following, exclufive of the action of the preceding falts, which has not yet been examined fufficiently to be mentioned.

Oxigenated muriates 0.

1, 2, 3, 4.

The phofphates of pot-afh, foda, ammonia, and magnefia, decompofe it by *fuperfluous attraction.*

3

attraction. The refults are phofphate of filex, and muriate of pot-afh, foda, ammonia, and magnefia.

The phofphites act like the phofphates.

5, 6, 7.

The fluates of ftrontian, magnefia, and pot-afh, feem to decompofe this falt?

8, 9.

The fluates of foda and ammonia decompofe the muriate of filex : the products are fluate of filex, and muriates of foda and ammonia.

10, 11, 12.

The borates of pot-afh, foda, and ammonia, decompofe the muriate of filex by *fuperfluous attraction,* producing borate of filex, and the refpective muriates.

13, 14, 15, 16, 17, 18.

The carbonates of barites, lime, pot-afh, foda, ammonia, and magnefia, decompofe the muriate of filex, and muriates are obtained, differing according to the carbonates employed, without carbonate of filex being formed.

LX.

LX. to LXVIII. inclufively.

OXIGENATED MURIATES.

THE nine fpecies of oxigenated or fuper-oxigenated muriates, are yet too little known for it to have been poffible to appreciate the effects of double attraction between them and all the other fpecies of falts.

Even the decompofitions of which the fuper-oxigenated muriate of pot-afh, the only one known, is fufceptible, have not yet been pointed out.

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LXIX. PHOSPHATE OF BARITES.

IT is decompofed by the two following, befide the thirteen *fulphates*, three *fulphites*, fix *nitrites*, fix nitrates, and feven *muriates*, already noticed.

1.

Carbonate of pot-afh. The products are carbonate of barites, and phofphate of pot-afh: the double attraction is neceffary.

2. Carbonate

2.

Carbonate of foda. The products are carbonate of barites, and phofphate of foda : the double attraction is neceffary.

LXX. Phosphate of Lime.

IT is decompofed by the five following :

1, 2, 3, 4, 5.

Phofphite of barites?
Fluate of barites;
Fluate of pot-afh;
Fluate of foda;
Borate of barites.

LXXI. Acid Phosphate of Lime.

IT is decompofed by the eighteen following, befide the nine *fulphates* or *fulphites* already mentioned.

Nitrates, nitrites, muriates, oxigenated muriates 0.

1. Phof-

1.

Phofphite of lime: the excefs of the phof-phoric acid combines with the lime, and fets the phofphoric acid free.

2.

Phofphite of barites.

3.

Phofphite of ftrontian: with this the fame thing occurs as with the phofphite of lime.

4, 5, 6, 7.

Fluates of barites, pot-afh, foda, and ammonia.

8, 9, 10.

Borates of barites, pot-afh, and foda.

11, 12, 13, 14, 15, 16, 17, 18.

Carbonates of barites, ftrontian, lime, pot-afh, foda, magnefia, ammonia, and glucine.

Thefe eight falts, that is to fay, all the carbonates, only faturate the excefs of phofphoric acid, whence refult two different phofphates

unlefs

unlefs when the carbonate of lime is employed); namely, a phofphate with the bafe of the carbonate employed, and phofphate of lime.

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LXXII. Phosphate of Strontian.

IT is decompofed by the thirteen following, befide the five *fulphates* or *fulphites*, four *nitrates*, and fix *muriates*, already mentioned.

1, 2.

Phofphites of barites and pot-afh.

3, 4, 5, 6.

Fluates of barites, pot-afh, foda, and ammonia.

7, 8, 9.

Borates of barites, pot-afh, and foda.

10, 11, 12, 13.

Carbonates of barites, lime, pot-afh, and foda.

LXXIII.

LXXIII. Phosphate of Pot-Ash.

IT is decompofed by the eight following, befide the fixteen *fulphates or fulphites*, ten *nitrates*, and eleven *muriates*, mentioned above. (Oxigenated muriates and nitrates 0.)

1, 2.

Phofphites of lime and barites.

3, 4.

Fluates of lime and barites.

5, 6.

Borates of lime and barites.

7, 8.

Carbonates of barites and lime.

———

LXXIV. Phosphate of Soda.

IT is decompofed by the twelve following, befide the fifteen *fulphates* or *fulphites*, nine *nitrates*, and ten *muriates*, mentioned above.

1, 2.

1, 2, 3.

Phofphites of lime, barites, and pot-afh.

4, 5, 6.

Fluates of lime, barites, and pot-afh.

7, 8, 9.

Borates of lime, barites, and pot-afh.

10, 11, 12.

Carbonates of barites, lime, and pot-afh.

———

LXXV. Phosphate of Ammonia.

IT is decompofed by the twenty-three fol-
lowing, befide the fifteen *fulphates* and *ful-
phites*, eight *nitrates*, and nine *muriates*, al-
ready mentioned.

1, 2, 3, 4, 5, 6.

Phofphites of lime, barites, ftrontian, mag-
nefia, pot-afh, and foda.

7, 8,

7, 8, 9, 10, 11, 12.

Fluates of lime, barites, ſtrontian, magneſia, pot-aſh, and ſoda.

13, 14, 15, 16, 17, 18,

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, and ſoda.

19, 20, 21, 22, 23.

Carbonates of barites, ſtrontian, lime, pot-aſh, and ſoda.

————

LXXVI. Phosphate of Soda and Ammonia.

IT is decompoſed by the nineteen following, beſide the five *ſulphates* and *ſulphites*, and the *nitrate* already mentioned, (muriates 0.)

1, 2, 3, 4.

Phoſphites of lime, barites, pot-aſh, and ſoda, with reſpect to the ammonia.

5, 6.

5, 6, 7, 8, 9.

Fluates of lime, barites, ftrontian, pot-afh, and foda, with refpect to the ammonia.

10, 11, 12, 13, 14, 15.

Borates of lime, barites, ftrontian, pot-afh, foda, and fuper-faturated with foda.

16, 17, 18, 19.

Carbonates of barites, lime, pot-afh, and foda.

LXXVII. PHOSPHATE OF MAGNESIA.

IT is decompofed by the twenty following, befides the feven *fulphates* and *fulphites*, three *nitrates*, and four *muriates*, already mentioned.

1, 2, 3, 4, 5.

Phofphites of lime, barites, ftrontian, pot-afh, and foda.

6, 7.

6, 7, 8, 9, 10, 11.

Fluates of lime, barites, ſtrontian, pot-aſh, ſoda, and ammonia.

12, 13, 14, 15, 16.

Borates of lime, barites, ſtrontian, pot-aſh, and ſoda.

17, 18, 19. 20.

Carbonates of ſtrontian, Lime, pot-aſh, and ſoda.

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LXXVIII. AMMONIACO-MAGNESIAN PHOSPHATE.

IT is decompoſed by the nineteen following, beſide the ſeven *ſulphates* and *ſulphites* already mentioned.

(Nitrates and muriates 0.)

1, 2, 3, 4, 5.

Phoſphites of lime, barites, ſtrontian, pot-aſh, and ſoda.

6, 7, 8, 9, 10.

Fluates of lime, barites, ſtrontian, pot-aſh, and ſoda.

11, 12, 13, 14, 15.

Borates of lime, barites, ftrontian, pot-afh, and foda.

16, 17, 18, 19.

Carbonates of ftrontian, lime, pot-afh, and foda.

LXXIX. PHOSPHATE OF GLUCINE.

IT is decompofed by the twenty-feven following, befide the ten *fulphates*, and *fulphites*, two *nitrates*, and two *muriates*, already noticed.

1, 2, 3, 4, 5, 6, 7.

Phofphites of lime, barites, ftrontian, magnefia, pot-afh, foda, and ammonia.

8, 9, 10, 11, 12, 13, 14.

Fluates of lime, barites, ftrontian, magnefia, pot-afh, foda, and ammonia.

15, 16, 17, 18, 19, 20, 21.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia.

22, 23, 24, 25, 26, 27.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, and ammonia.

LXXX. PHOSPHATE OF ALUMINE.

IT is decompoſed by the thirty following, beſide the eleven *ſulphates* and *ſulphites*, one *nitrate*, and one *muriate*, already mentioned.

1, 2, 3, 4, 5, 6, 7.

Phoſphites of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia.

8, 9, 10, 11, 12, 13, 14, 15.

Fluates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, and glucine.

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16, 17,

16, 17, 18, 19, 20, 21, 22.

Borates of lime, barites, ſtrontian, magne-
ſia, pot-aſh, ſoda, and ammonia.

23, 24, 25, 26, 27, 28, 29, 30.

Carbonates of barites, ſtrontian, lime, pot-
aſh, ſoda, magneſia, ammonia, and glucine.

LXXXI. PHOSPHATE OF ZIRCONE.

IT is decompoſed by the thirty-four follow-
ing, beſide the ten *ſulphites* already mentioned
(ſulphates, nitrates, and muriates, 0.)

1, 2, 3, 4, 5, 6, 7, 8, 9.

Phoſphites of lime, barites, ſtrontian, magne-
ſia, pot-aſh, ſoda, ammonia, glucine, and alu-
mine.

10, 11, 12, 13, 14, 15, 16, 17.

Fluates of lime, barites, ſtrontian, magneſia,
pot-aſh, ſoda, ammonia, and glucine.

18, 19,

18, 19, 20, 21, 22, 23, 24, 25.

Borates of lime, barites, ftrontian, magnefia, pot-afh, foda, ammonia, and glucine.

26, 27, 28, 29, 30, 31, 32, 33, 34.

Carbonates of ftrontian, lime, pot-afh, foda, ammonia, magnefia, ammoniaco-magnefian, glucine, and alumine.

LXXXII. PHOSPHATE OF SILEX.

IT is decompofed by the thirty-nine following, befide one *fulphate* already mentioned, (fulphites, nitrates, and muriates, 0.)

1, 2, 3, 4, 5, 6, 7, 8, 9.

Phofphites of lime, barites, ftrontian, magnefia, pot-afh, foda, ammonia, alumine, and glucine.

10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20.

Fluates of lime, barites, ftrontian, magnefia, pot-afh, foda, ammonia, alumine, glucine, and two triple.

21, 22

21, 22, 23, 24, 25, 26, 27, 28, 29, 30.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, alumine, glucine, and zircone.

31, 32, 33, 34, 35, 36, 37, 38, 39.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, ammonia, magneſia, alumine, and glucine.

LXXXIII, to XCIII, Incluſively.

THE eleven ſpecies of phoſphites, which I have deſcribed, have not yet been ſufficiently examined, to render it poſſible to exhibit any thing like an exact ſeries of the double decompoſitions, which they are capable of undergoing with the fluates, borates, and carbonates. In the ſeven preceding genera of ſalts the action of moſt of the phoſphites, on the ſulphates, ſulphites, nitrates, nitrites, muriates, and phoſphates, has appeared. To theſe decompoſitions it is eaſy to add thoſe of the phoſphites by the fluates, borates, carbonates, with regard to which their capability of being altered muſt nearly approach what has been at-

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tributed

tributed to the phofphates: but thefe efforts, probable as they are, not having been verified by experiments, I have not thought it proper to give them here at large, as I have done with the preceding, and fhall do with the fub-fequent genera.

XCIV. Fluate of Lime.

IT is decompofed by the two following, befide the ten *phofphates* already mentioned, (fulphates, fulphites, nitrates, nitrites, muriates, and oxigenated muriates, O.)

1.

Carbonate of pot-afh.

2.

Carbonate of foda.

XCV. Fluate of Barites.

IT is decompofed by the eight following, befide the fixteen *fulphates* and *fulphites*, three *nitrates,*

nitrates, ten *muriates,* and twelve *phofphates,* already mentioned.

1, 2, 3, 4.

Borates of lime, pot-afh, foda, fuperfaturated of foda.

5, 6, 7, 8.

Carbonate of lime, pot-afh, foda, and ammonia.

XCVI. FLUATE OF STRONTIAN.

IT is decompofed by the feven following, befides the fourteen *fulphates* and *fulphites,* eight *nitrates,* nine *muriates,* and eight *phofphates,* already mentioned.

1, 2, 3.

Borates of barites, pot-afh, and foda.

4, 5, 6, 7.

Carbonates of lime, pot-afh, foda, and ammonia.

XCVIII.

XCVII. Fluate of Magnesia.

IT is decompofed by the ten following, befide the eight *fulphates* and *fulphites*, one *nitrate*; fix *muriates*, five *phofphates*, already mentioned.

1, 2, 3, 4, 5.

Borates of lime, barites, ftrontian, pot-afh, and foda.

6, 7, 8, 9, 10.

Carbonates of ftrontian, lime, pot-afh, foda, and ammonia.

XCVIII. Fluate of Pot-Ash.

IT is decompofed by the three following, befide the ten *fulphates and fulphites*, ten *nitrates*, eleven *muriates*, and twelve *phofphates*, already noticed.

1, 2, 3.

Borates of lime, barites, and ftrontian.

XCIX.

XCIX. Fluate of Soda.

IT is decompofed by the fix following, befide the nine *fulphates* and *fulphites*, nine *nitrates*, ten *muriates*, and ten *phofphates*, already mentioned.

1, 2, 3, 4.

Borates of lime, barites, ftrontian, and potafh.

5, 6.

Carbonates of pot-afh and ammonia?

C. Siliceous Fluate of Soda.

THE manner in which it acts with the other falts is not known.

CI. Fluate of Ammonia.

IT is decompofed by the eight following, befide the nine *fulphates* and *fulphites*, eight *nitrates*,

trates, eight *muriates*, and feven *phofphates*, already mentioned.

1, 2, 3, 4, 5.

Borates of lime, barites, ftrontian, pot-afh, and foda.

6, 7, 8.

Carbonates of lime, pot-afh, and foda.

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CII. Ammoniaco-Magnesian Fluate.

IT is decompofed by the ten following; its action on the preceding has not been examined.

1, 2, 3, 4, 5.

Borates of lime, barites, ftrontian, pot-afh, and foda.

6, 7, 8, 9, 10.

Carbonates of ftrontian, lime, lime, pot-afh, foda, and ammonia.

CIII.

CIII. Ammoniaco-Siliceous Fluate.

ITS action on the other falts is not known.

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CIV. Fluate of Glucine.

IT is decompofed by the fourteen following, befide the four *fulphates* or *fulphites,* and three *phofphates,* already mentioned.

1, 2, 3, 4, 5, 6, 7.

Borates of lime, barites, ftrontian, magnefia, pot-afh, foda, and ammonia.

8, 9, 10, 11, 12, 13, 14.

Carbonates of barites, ftrontian, lime, pot-afh, foda, magnefia, and ammonia.

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CV. Fluate of Alumine.

IT is decompofed by the fixteen following, befide the *phofphates* already mentioned.

1, 2,

1, 2, 3, 4, 5, 6, 7, 8.

Borates of lime, barites, ftrontian, magnefia, pot-afh, foda, ammonia, and glucine.

9, 10, 11, 12, 13, 14, 15, 16.

Carbonates of barites, ftrontian, lime, pot-afh, foda, magnefia,, ammonia, and glucine.

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CVI. Fluate of Zircone.

IT is decompofed by the eighteen following: its action on the preceding falts is not known.

1, 2, 3, 4, 5, 6, 7, 8, 9.

Borates of lime, barites, ftrontian, magnefia, pot-afh, foda, ammonia, glucine, and alumine.

10, 11, 12, 13, 14, 15, 16, 17, 18.

Carbonates of barites, ftrontian, lime, pot-afh, foda, magnefia, ammonia, alumine, and glucine.

CVII.

CVII. Fluate of Silex.

IT is decompofed by the twenty following, and is not decompofed by any of the preceding neutral falts.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11.

Borates of lime, barites, ftrontian, magnefia, pot-afh, foda, fuperfaturated of foda, ammonia, glucine, alumine, and zircone.

12, 13, 14, 15, 16, 17, 18, 19, 20.

Carbonates of barites, ftrontian, lime pot-afh, foda, ammonia, magnefia, glucine, and alumine.

CVIII. Borate of Lime.

IT is not decompofed by any of the following, but it is by ten *phofphates*, and ten *fluates* already noticed.

CIX. Borate of Barites.

IT is not decompofed by any of the following, but by eleven *fulphates* or *fulphites*, one *nitrate*, four *muriates*, twelve *phofphates*, and ten *fluates*, already mentioned.

CX. Borate of Strontian.

IT is decompofed by ten *fulphates* or *fulphites*, three *nitrates*, four *muriates*, feven *phofphates*, and nine *fluates*, already mentioned.

CXI. Borate of Magnesia.

IT is decompofed by the five following, befide the fix *fulphates* or *fulphites*, two *muriates*, five *phofphates*, and four *fluates*, already mentioned.

1, 2, 3, 4, 5.

Carbonates of barites, ftrontian, lime, potafh, and foda.

CXII.

CXII. Magnesio-Calcareous Borate.

ITS action on the other falts is not well known: it is decompofed by one muriate already mentioned.

CXIII. Borate of Pot-Ash.

IT is not decompofed by any of the following, but is by thirteen *fulphates* or *fulphites*, ten *nitrates*, nine *muriates*, ten *phofphates*, and ten *fluates*, already mentioned.

CXIV. Borate of Soda.

IT is decompofed by the carbonate of potafh, befide the eleven *fulphates* or *fulphites*, nine *nitrates*, eight *muriates*, eight *phofphates*, and eight *fluates*, already mentioned.

CXV. Supersaturated Borate of Soda.

IT acts like the preceding, and is decompofed like it.

3   CXVI.

CXVI. Borate of Ammonia.

IT is decompofed by the fix following, befide the ten *fulphates* or *fulphites*, feven *nitrates*, eight *muriates*, four *phofphates*, and four *fluates*, already mentioned.

1, 2, 3, 4, 5, 6.

Carbonates of barites, ftrontian, lime, potafh, foda, and magnefia.

CXVII. Ammoniaco-Magnesian Borate.

THE manner in which this falt acts upon others has not yet been examined.

CXVIII. Borate of Glucine.

IT is decompofed by the feven following, befide the two *phofphates*, and three *fluates*, already mentioned.

1, 2, 3, 4, 5, 6, 7.

Carbonates of barites, ftrontian, lime, pot-
afh, foda, magnefia, and ammonia.

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CXIX. Borate of Alumine.

IT is decompofed by the eight following,
befide one *phofphate*, and two *fluates*, already
mentioned.

1, 2, 3, 4, 5, 6, 7, 8.

Carbonates of barites, ftrontian, lime, pot-
afh, foda, magnefia, ammonia, and glucine.

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CXX. Borate of Zircone.

IT is decompofed by the nine following, be-
fide one *phofphate*, and one *fluate*, already
mentioned.

1, 2,

1, 2, 3, 4, 5, 6, 7, 8, 9.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, glucine, and alumine.

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CXXI. BORATE OF SILEX.

IT is decompoſed by the ten following. The preceding ſalts do not appear to have any action on it.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, glucine, alumine, and zircone.

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CXXII, to CXXXIV, Incluſively.

THE fourteen ſpecies of earthy and alkaline carbonates diſtinguiſhed and deſcribed in this fifth ſection, having been treated of in the CXXI preceding numbers, and being the laſt of all the ſaline ſubſtances, nothing more re-

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mains

mains to be faid refpecting their re-actions, and double decompofitions.

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ARTICLE XVI.

Recapitulation of the Compofition of the One Hundred and Thirty-Five Species of Salts, or Table of the Proportions of their conftituent Principles.

1. AFTER having perufed all that has preceded this part of my fyftem, the reader muft be fufficiently advanced in his ftudy of the fcience of chemiftry, readily to conceive, that an accurate knowledge of the phenomena of this fcience depends greatly on a determination of the refpective quantities of the principles that enter into the formation of compounds. Accordingly, fince chemiftry has changed its appearance, fince its means of analyfis have been increafed, and fince its inftruments have acquired fuch a great degree of perfection, compared with what they poffeffed thirty years ago, the principal object of the labours of chemifts has been, to inveftigate the proportions of the elements, that conftituted the different compounds on which their attention was employed. Among the ufeful refults, which refearches of this kind have furnifhed, the falts particularly offer

offer fome of great importance, either for ef-
fecting their decompofition with advantage,
knowing their nature with precifion, or appre-
ciating the effects in all the cafes in which they
are employed.

2. I have taken care, in the hiftory of each
particular fpecies, to exhibit this proportion of
its principles, after having pointed out the
method that has been purfued for analyzing it.
The enunciation of this has appeared to me fo
important for completing the chemical hiftory
of falts, that I have inferted it at the end of
this hiftory, that it may become as it were
its moft prominent point, and natural con-
clufion. But the utility of this refult of the
analyfis of falts muft become ftill much greater,
by bringing together the proportions of the
conftituent principles of each falt, fince it will
enable us to compare the refpective quantities
of the faline principles, the difference of the
reciprocal faturabilities of acids by the bafes,
and of bafes by the acids, the relation of thefe
proportions to the degrees of attraction that
unite them, either in the different fpecies of
the fame genus, or in fpecies of different
genera analogous to each other with refpect to
their bafes.

3. Befides which, this table exhibiting at a
fingle view the facts fcattered through a very
extenfive part of this work, it will fhow
what has been completed in this kind of ana-
lyfis, and what remains to be done. By com-
paring

paring it with that of the compofition of fome of the principal fpecies of falts given by Berg-mann in his differtation on the analyfis of waters, it will be capable of fhowing the pro-grefs made in chemiftry by thofe philofophers, who have purfued the new path barely opened by the illuftrious Swedifh profeffor. I fhall proceed to give it, adopting for the 135 fpecies of falts the fame order in which I have already placed and defcribed them, only adding be-fore each of them a number, which will point out, for this fixteenth article of the fifth fec-tion, the numerical feries, which I have pur-fued in each divifion of this work.

4. *Sulphate of Barites.*

A. Natural $\begin{cases} \text{Sulphuric acid} & 13 \\ \text{Barites} & - & - & 84 \\ \text{Water} & - & - & 3 \end{cases}$

B. Artificial $\begin{cases} \text{Sulphuric acid} & 33 \\ \text{Barites} & - & - & 64 \\ \text{Water} & - & - & 3 \end{cases}$

5. *Sulphate of Pot-Afh.*

Sulphuric acid - 40
Pot-afh - - - 52
Water - - - 8

6. *Acid*

6. *Acid Sulphate of Pot-Aſh.*

Sulphate of pot-aſh 67
Sulphuric acid -   33

7. *Sulphate of Soda.*

Sulphuric acid - 27
Soda - - - 15
Water - - - 58

8. *Sulphate of Strontian.*

Sulphuric acid - 46
Strontian - - - 54

9. *Sulphate of Lime.*

Sulphuric acid - 46
Lime - - - - 32
Water - - - - 22

10. *Sulphate of Ammonia.*

Sulphuric acid - 42
Ammonia - - 40
Water - - - 18

11. *Sulphate*

11. *Sulphate of Magnesia.*

Sulphuric acid - 33
Magnesia - - 19
Water - - - 48

12. *Ammoniaco-Magnesian Sulphate.*

Sulphate of magnesia 68
Sulphate of ammonia 32

13. *Sulphate of Glucine.*

Proportions unknown.

14. *Sulphate of Alumine.*

Neutral { sulphuric acid 50
Alumine - 50

15. *Acid Sulphate of Alumine, and of Pot-Ash, or Ammonia, or Alum.*

Sulphate of alumine 49
Sulphate of pot-ash 7
Water - - - - 44

16. *Saturated triple Sulphate of Alumine.*

Proportions not exactly known.

17. *Sulphate*

17. *Sulphate of Zircone.*

Proportions unknown.

18. *Sulphite of Barites.*

Sulphureous acid - 39
Barites - - - 59
Water - - - 2

19. *Sulphite of Lime.*

Sulphureous acid - 48
Lime - - - - 45
Water - - - 5

20. *Sulphite of Pot-Afh.*

Proportions not yet known.

21. *Sulphite of Soda.*

Sulphureous acid - 31
Soda - - - - 18
Water - - - 51

22. *Sulphite of Strontian.*

Proportions not yet known.

23. *Sulphite*

23. *Sulphite of Ammonia.*

Sulphureous acid   60
Ammonia   -   29
Water   -   -   11

24. *Sulphite of Magnefia.*

Sulphureous acid   39
Magnefia   -   16
Water   -   -   45

25. *Ammoniaco-magnefian Sulphite.*

Proportions unknown.

26. *Sulphite of Glucine.*

Proportions unknown.

27. *Sulphite of Alumine.*

Sulphureous acid   32
Alumine   -   -   44
Water   -   24

28. *Sulphite of Zircone*

Proportions unknown.

S

29. *Nitrate*

29. *Nitrate of Barites.*

Nitric acid	-	38
Barites	-	50
Water	-	12

30. *Nitrate of Pot-Afh.*

Nitric acid	-	33
Pot-afh	-	49
Water	-	18

Bergmann.

Nitric acid	-	30
Pot-afh	-	63
Water	-	7

Kirwan.

31. *Nitrate of Soda.*

Nitric acid	-	29
Soda	-	50
Water	-	21

32 *Nitrate of Strontian.*

Nitric acid		48,4
Strontian	-	47,6
Water	-	4,0

33. *Nitrate*

33. *Nitrate of Lime.*

Nitric acid -   - 43
Lime   -   - 32
Water   -   - 25

34. *Nitrate of Ammonia.*

Nitric acid   -   46
Ammonia -   - 40
Water   -   - 14

35. *Nitrate of Magnesia.*

Nitric acid   -   43
Magnesia -   - 27
Water -   - 30

36. *Ammoniaco-magnesian Nitrate.*

Nitrate of ammonia 22
Nitrate of magnesia 78

37. *Nitrate of Glucine.*

Proportions not ascertained.

38. *Nitrate of Alumine.*

Proportions unknown.

39. *Nitrate*

39 *Nitrate of Zircone.*

Proportions unknown.

40. *Nitrite of Barites.*

41. *Nitrite of Pot-Afh.*

42. *Nitrite of Soda.*

43. *Nitrite of Strontian.*

44. *Nitrite of Lime.*

45. *Nitrite of Ammonia.*

46. *Nitrite of Magnefia.*

47. *Ammoniaco-magnefian Nitrite.*

48. *Nitrite of Glucine.*

49. *Nitrite of Alumine.*

50. *Nitrite of Zircone.*

No nitrite has yet been carefully examined; and we know not the proportions of the principles of any one.

51. *Muriate of Barites.*

Muriatic acid - 24
Barites - - 60
Water - - 16

52. *Muriate*

52. *Muriate of Pot-Aſh.*

Muriatic acid	-	30
Pot-aſh -	-	62
Water -	-	8

53. *Muriate of Soda.*

Muriatic acid	52	
Soda - -	42	} Bergmann.
Water - -	6	

Muriatic acid	33	
Soda - -	50	} Kirwan.
Water - -	17	

54. *Muriate of Strontian.*

Muriatic acid		23,6
Strontian	-	36,4
Water	-	40,0

55. *Muriate of Lime.*

Muriatic acid	-	31
Lime	-	44
Water	-	25

56. *Muriate of Ammonia.*

Muriatic acid	-	52
Ammonia	- -	40
Water	- -	8

57. *Muriate of Magnesia.*

Muriatic acid	-	34
Magnesia	- -	41
Water -	-	25

58. *Ammoniaco-magnesian Muriate.*

Muriate of ammonia 27
Muriate of magnesia 73

59. *Muriate of Glucine.*

Proportions unknown.

60. *Muriate of Alumine.*

Proportions unknown.

61. *Muriate of Zircone.*

Proportions unknown.

62. *Muriate*

62. *Muriate of Silex.*

Proportions unknown.

63. *Super-oxigenated Muriate of Barites.*

Proportions unknown.

64. *Super-oxigenated Muriate of Pot-Aſh.*

Muriate of pot-aſh   67
Oxigen   -   -   33

65. *Super-oxigenated Muriate of Soda,*

66. *Super-oxigenated Muriate of Strontian.*

67. *Super-oxigenated Muriate of Lime.*

68. *Super-oxigenated Muriate of Magneſia.*

69. *Super-oxigenated Muriate of Glucine.*

70. *Super-oxigenated Muriate of Alumine.*

71. *Super-oxigenated Muriate of Zircone.*

The exiſtence of the ſuper-oxigenated muri-
ates, in general, being at preſent little more
than conjectured, we cannot yet have any idea
of the proportions of their principles.

72. *Phoſphate*

72. *Phosphate of Barites.*

Proportions unknown.

73. *Phosphate of Strontian.*

Phosphoric acid 41,24
Strontian   -   58,76

74. *Phosphate of Lime.*

Phosphoric acid   41
Lime   -   -   59

75. *Acid Phosphate of Lime.*

Phosphoric acid   54
Lime   -   -   -   46

76. *Phosphate of Pot-Ash.*

Proportions unknown.

77. *Phosphate of Soda.*

Proportions unknown.

78. *Phosphate of Ammonia.*

Proportions unknown.

79. *Phofphate of Soda and Ammonia.*

Phofphoric acid	32
Soda - -	24
Ammonia - -	19
Water - -	25

80. *Phofphate of Magnefia.*

Proportions unknown.

81. *Ammoniaco-magnefian Phofphate.*

Magnefian phofphate	50
Ammoniacal phofphate	25
Water - -	25

82. *Phofphate of Glucine.*

Proportions unknown.

83. *Phofphate of Alumine.*

Proportions unknown.

84. *Phofphate of Zircone.*

Proportions unknown.

85. *Phofphate*

85. *Phosphate of Silex.*

Proportions unknown.

86. *Phosphite of Lime.*

Phosphoreous acid 34
Lime - - 51
Water - - 15

87. *Phosphite of Barites.*

Phosphoreous acid 41,7
Barites - - 51,3
Water - - 7,0

88. *Phosphite of Strontian.*

Proportions unknown.

89. *Phosphite of Magnesia.*

Phosphoreous acid 44
Magnesia - 20
Water - - 36

A a 2   90. *Phosphite*

90. *Phofphite of Pot-Afh.*

Phofphoreous acid 39,5
Pot-afh   -   -   49,5
Water   -   -   11,0

91. *Phofphite of Soda.*

Phofphoreous acid 16,3
Soda   -   23,7
Water,   -   -   60,0

92. *Phofphite of Ammonia.*

Phofphoreous acid   26
Ammonia   -   -   51
Water   -   -   23

93. *Ammoniaco-magnefian Phofphite.*

Proportions unknown.

94. *Phofphite of Glucine.*

Proportions unknown.

95. *Phofphite of Alumine.*

Proportions unknown.

96. *Phofphite*

96. *Phofphite of Zircone.*

Proportions unknown.

97. *Fluate of Lime.*

Proportions unknown.

98. *Fluate of Barites.*

99. *Fluate of Strontian.*

100. *Fluate of Magnefia.*

101. *Fluate of Pot-Afh.*

102. *Siliceous Fluate of Pot-Afh.*

103. *Fluate of Soda.*

104. *Siliceous Fluate of Soda.*

105. *Fluate of Ammonia.*

106. *Ammoniaco-magnefian Fluate.*

107. *Ammoniaco-filiceous Fluate.*

108. *Fluate of Glucine.*

109. *Fluate of Alumine.*

110. *Fluate of Zircone.*

111. *Fluate of Silex.*

The

The proportions of the principles of no one of the fluates are yet known. Thefe falts, hitherto little examined, require an affiduous inveftigation to enable us to afcertain their component parts. They, and the fuper-oxigenated muriates are the fpecies that have been leaft accurately analyzed to the prefent day.

112. *Borate of Lime.*

Proportions not yet known.

113. *Borate of Barites.*

Unknown, like the preceding.

114. *Borate of Strontian.*

Proportions unknown.

114*. *Borate of Magnefia.*

Proportions unknown.

115. *Magnefio-calcareous Borate.*

Boracic acid   66 ⎫ Here is a lofs
Magnefia   13,5 ⎬ of 10.
Lime   -   - 10,5 ⎭

116. *Borate of Pot-Afh.*

Proportions unknown.

117. *Borate*

117. *Borate of Soda.*

Boracic acid - 70
Soda - - 20
Water - - 10

118. *Super-saturated Borate of Soda : Borax.*

Boracic acid - 34
Soda - - 17
Water - - 47

119. *Borate of Ammonia.*

Proportions unknown.

120. *Ammoniaco-magnesian Borate.*

Proportions unknown.

121. *Borate of Glucine.*

Proportions unknown.

122. *Borate of Alumine.*

Proportions unknown.

123. *Borate of Zircone.*

Proportions unknown.

124. *Borate*

124. *Borate of Silex.*

Proportions unknown.

125. *Carbonate of Barites.*

A. *Native.*
Carbonic acid	20	
Barites -	78	Kirwan.
Sulphate of barites	2	
Carbonic acid	10	Fourcroy.
Barites - -	90	
Carbonic acid	32	
Barites -	62	Pelletier.
Water -	16	

B. Artificial.
Carbonic acid	7	
Barites - -	65	Kirwan.
Water - -	28	

126. *Carbonate of Strontian.*

Carbonic acid - 30
Strontian - - 62
Water - - 8

127. *Carbonate of Lime.*

Carbonic acid - 34
Lime - - 55
Water - - 11

128. *Carbonate of Pot-Afh.*

Carbonic acid	20	
Pot-afh - -	48	Bergman.
Water - - -	32	
Carbonic acid	49	
Pot-afh -	48	Pelletier.
Water -	17	Here is an

excefs of weight.

129. *Carbonate of Soda.*

Carbonic acid -	16
Soda - - -	20
Water - -	64

130. *Carbonate of Magnefia.*

A. Saturated with acid	Carbonic acid	30	
	Magnefia -	45	Bergman.
	Water -	25	
B. Pulverulent magnefia of the fhops	Carbonic acid	36	
	Magnefia	43	Butini.
	Water -	21	
The fame	Carbonic acid	48	
	Magnefia -	40	Fourcroy.
	Water -	12	
C. Carbonate of magnefia in regular cryftals.	Carbonic acid	50	
	Magnefia	25	Fourcroy
	Water	25	

131. *Carbonate of Ammonia.*

Carbonic acid　-　45
Ammonia　　-　43
Water　-　-　-　12

132. *Ammoniaco-Magnesian Carbonate.*

Proportions not yet known.

133. *Carbonate of Glucine.*

Carbonic acid　-　64
Glucine　-　-　25
Water　-　-　11

134. *Carbonate of Alumine.*

Proportions unknown.

135. *Carbonate of Zircone.*

Carbonic acid and water　44,5
Zircone　-　-　-　-　55,5

136. *Ammoniaco-Zirconian Carbonate.*

Proportions unknown.

137. *Ammoniaco-*

137. *Ammoniaco-Glucinian Carbonate.*

Proportions unknown.

Article XVII.

Recapitulation of the Salts that are found fossil, and on their Classification in mineralogical Methods or Systems.

1. THOUGH I have taken care, in the history of each species of salts, to note whether it were found among fossils, and even in general, to describe the principal varieties under which it appears, it will not be without its use, to revert again to the existence of these substances in the strata of the earth, to compare them with such as have not yet been met with in those strata, and to point out the path pursued by mineralogists both for the classification and discrimination of these substances.

2. I shall first remind the reader, that of the 135 species of salts, which I have arranged and described in the preceding articles, those that have been found in the earth, and form part of the strata which compose it, amount at most to an eighth part, or thereabout. It is true I have supposed, that nature prepares a much greater number; and that, though we remain hitherto unacquainted with them, it is because we have

too

too fuperficially viewed, and not enough exa-
mined, feveral mineral fubftances, in which a
more accurate analyfis will hereafter enable us
to difcover them. We fhall be led to embrace
this opinion, if we reflect on the fmall quantity
of minerals yet explored, and the little accurate
knowledge collected refpecting moft of them.

3. Mineralogy, however, has gained much in
this refpect within thefe few years; and parti-
cularly fince mineralogifts, not content with
the external characters or an examination of the
phyfical properties of foffils, have begun to add
chemical experiments to their obfervations, and
to inveftigate the intrinfic nature of thefe fub-
ftances. Every thing indicates, that the faline
compounds daily created and multiplied by art,
are mere imitations of fuch as nature has formed;
and that, in proportion as the fcience of analyfis
advances, we fhall difcover new fpecies of foffil
falts, analogous to thofe which we have hitherto
only fabricated in our chemical laboratories.

4. The ancient chemifts knew fcarcely more
than a third of the falts with which we are now
acquainted. Many of thefe falts were ranked
by mineralogifts in the clafs of ftones, on ac-
count of their infipidity and infolubility, or of
the great quantity of water requifite to diffolve
them. Thus the fulphate, carbonate, and fluate
of lime, under the names of gypfum, calcareous
fpar, and fluor fpar, conftituted a part of the
ftony fubftances, becaufe they were infipid and
infoluble. The ancient method, being founded

exclu-

exclufively on the fenfible properties of foffils, could not place thefe infipid and infoluble bodies by the fide of the muriate, carbonate, and borate of foda, the nitrate of pot-afh, and the triple fulphate of alumine, the falt, bitter, acrid, alkaline, pungent tafte, and great folubility of which formed too ftriking a contraft to the characters of the former. Thus the clafs of falts was of very confined extent, compared with the other claffes of minerals, while the very numerous varieties of the carbonate of lime alone conftituted an entire clafs among the ftony foffils.

5. This method is ftill to be found in Citizen Daubenton's fyftematic view of minerals. The fluor fpar or fluate of lime, heavy fpar or ful-phate of barites, aërated barites or carbonate of barites, phofphate of lime, and apatite, which is but a variety of it, are ftill placed by this na-turalift among the earths and ftones of the fe-cond clafs, which neither ftrike fire with fteel nor effervefce with acids, becaufe the infoluble falts in fact poffefs thefe properties. His third clafs is formed entirely of the carbonate of lime in the different ftates of calcareous ftone, cal-careous earth, marble, calcareous fpar, and con-cretions, conftituting five genera; becaufe all thefe varieties of one fubftance, being infoluble in water, equally poffefs the conftant and un-equivocal property of effervefcing with acids. Finally, he not only feparates from thefe faline fubftances, which are to him ftones, the falts

por-

properly fo called, the foffil falts, to which he affigns as a diftinguifhing characteriftic folubility in water, but he makes of thefe falts a fourth order, feparated and kept at a diftance from the calcareous fubftances, his third clafs of ftones, by a fourth clafs, which comprifes the earths and ftones that are mixtures of thofe of the three foregoing claffes.

6. After this removal and diftribution of five fpecies of falts into two different claffes of ftones, Citizen Daubenton, confidering as falts only thofe foffil fpecies which are foluble in water; divides thefe into three genera, the firft having an alkaline, the fecond an earthy, and the third a metallic bafe. The laft belongs wholly, in all other methods, to the clafs of metals: and the other two prefent a deficiency, which proves it is impoffible to make a good claffification of thefe falts without having recourfe to their chemical properties; namely, the want of generic characters, which does not allow a real diftinction to be made between them.

7. The firft genus of Citizen Daubenton comprifes five fpecies; 1ft, the carbonate of foda, under the name of *mineral alkali*, with the two varieties of *natron* and *aphronatron*, the characters affigned to which are effervefcence with acids, and cryftallization in octahedra with fcalene triangles; 2d, the muriate of foda, named *common falt*, divided into fea falt and fal gem, diftinguifhed by its decrepitation in the fire,

4   its

its cubical fragments, its cryftallization in cubes, and in hollow truncated pyramids; 3d, borax, having as varieties tincal, or crude borax, and purified borax, and as fpecific characters a gelatinous tranfparency, ebullition in the fire, and the figure of a fix-fided prifm with polyhedral fummits; 4th, fal-ammoniac, native or factitious, volatilizing in vapour, under a granulous form, or in feathery cryftals compofed of tetrahedral prifms with quadrangular pyramids; 5th, nitre, or faltpetre, detonating on burning coals, and diftinguifhed into two varieties of form, one a cuneiform octahedron, the other with two commencing quadrangular pyramids.

8. The fecond genus of this celebrated French naturalift, includes under the name of earthy falts, four fpecies, which are *calcareous* nitre, *gypfum*, *Epfom* falt, and *alum*.

The nitrate of lime is characterized by its great deliquefcence. Two varieties of figure are mentioned; one hexahedral prifms, terminated by hexagonal pyramids; the other in needles.

The fulphate of lime, diftinguifhable by calcining into plafter, and being little foluble in water, contains nine varieties: 1ft, the coarfe opaque; 2d, the coarfe femi-tranfparent; 3d, the fine opaque; 4th, the fine femi-tranfparent, or *gypfous alabafter*; 5th, the ftriated opaque; 6th, the ftriated femi-tranfparent; 7th, the decahedral fulphate of lime; 8th, the fame in ag-

<div align="right">glutinated</div>

glutinated cryftals; 9th, the lenticular fulphate of lime.

The fulphate of magnefia, eafily diftinguifhed by its bitter tafte, has two varieties; one in tetrahedral prifms with dihedral fummits, the other in tetrahedral prifms with quadrangular fummits.

The triple fulphate of alumine, or alum, which our author characterizes by its limpid tranfparency and glaffy fracture, is divided into five varieties; namely, a regular octahedron, an octahedron incomplete on its edges and folid angles, a fegment of an octahedron, a fhapelefs mafs, and feathery, or in filaments.

By adding the nine varieties of the three metallic fulphates, which Citizen Daubenton joins with the preceding fpecies, we have three genera, twelve fpecies, and thirty-feven varieties of faline fubftances, which he admits in his mineralogical method, a much more confiderable number than the naturalifts before him had enumerated.

9. In the method of claffing minerals adopted by the French fchool of mines, and made public by Citizen Haüy, to whom we are indebted for it, faline fubftances are diftinguifhed from ftones, and form a fecond clafs, entitled, *acidiferous fubftances, compofed of an acid united to an earth or an alkali.* The name of falts has not been employed in it, as is done, and ought to be done, in a chemical fyftem. This diftribution fhows at once, that the author has carefully

fully feparated the faline compounds from the
ftony, that he has avoided the confufion hitherto
prevalent in fyftems of mineralogy, and that he
has felt the imperious neceffity of no longer in-
cluding in the fame clafs falified or acidiferous
fubftances, and fubftances which are not fo.
He informs us, that the method adopted in this
fecond clafs follows a regular courfe, becaufe
it is fubordinate to the refults of analyfis. This
is confeffing, and with good reafon, that there
are no true diftinctions between minerals, unlefs
they be founded on the nature of foffils. The
advantage of fuch a courfe, is not only to intro-
duce order and connexion of ideas, but alfo
giving accurate notions of the fubftances to be
defined or made known. We fee likewife, that
this part of mineralogy is precife and complete,
only becaufe the chemical analyfis of the fub-
ftances on which it treats is finifhed and exact.

10. The divifions of this fecond clafs of
minerals exhibits three orders, founded on the
nature of the bafes. It is on thefe that the
French mineralogifts have eftablifhed their me-
thods, inftead of taking their diftinctions from
the acids, becaufe the notions of the mineralogift
are more particularly turned to the earths and
alkalis, which are confidered only as acidiferous.
Accordingly, the denominations of the fpecies
begin with thofe of the bafes, to which thofe
of the acids are added, giving them an adjec-
tive termination. In this clafs there are three
orders : the firft comprifes the earthy acidiferous

substances; the second, alkaline acidiferous substances; and to the third, the alkalino-earthy acidiferous substances are referred. Here the division is very irregular; for we find but one single species, without a genus, in the third order, while in the two preceding both the species and genera are more or less numerous. The reason why the bases have been taken as the heads of divisions in this new method, turns chiefly on this, that, the mineralogist having to observe nature, his attention ought to be more particularly fixed on what strikes the senses, by the more fixed substance, not by that which most frequently escapes. The earths and alkalis, in fact, come under the former description; the acids, under the latter. Besides, the mineralogist ought to content himself with applying the results of analysis to the observation and operations of nature; while the chemist, on the contrary, endeavours to refer the operations of nature to the results of analysis.

11. The first order includes the earthy acidiferous substances. It is divided into four genera, determined by the four earths already found saturated with acid in a native state; namely, lime, barites, strontian, and magnesia. It may be observed, that we here mention only four alkaline earths; and in fact, silex, alumine, glucine, and zircone, have not yet been found acidiferous among fossils. We may consider certain clays, however, as sulphate of alumine,

and

and fome varieties of fluate of lime as filiciferous triple falts, as I have elfewhere fhown.

12. The firft genus, or acidiferous lime, offers five fpecies; *carbonated lime, phofphated lime, fluated lime, borated lime,* and *fulphated lime.*

In the varieties of the firft fpecies about forty determinate forms are defcribed; but as the number of thefe varieties appears to be immenfe, Citizen Haüy has divided this fpecies into three fections of determinate forms, imitative forms, indeterminate forms.

The phofphated lime exhibits among the determinate forms the *primitive,* the *peridodecahedral,* the *annular,* the *emarginated,* and the *acroftic.*

The fluated lime offers, of varieties for the fame forms, the *primitive* or *octahedral,* the *cubic,* the *dodecahedral,* the *cubo-octahedral,* the *emarginated,* the *cubo-dodecahedral,* the *bordered;* among the indeterminate, the *alabeftrite,* and *irregular;* with refpect to colour, the *red, violet, green, blue, yellow,* and *blackifh violet;* and with refpect to tranfparency, the *limpid, femi-tranfparent,* and *opaque.*

The borated lime contains magnefia, as has been feen elfewhere: its form has two varieties, the *fruftaneous,* and the *fuperabundant.*

In the fulphated lime Citizen Haüy purfues the fame method for diftinguifhing its varieties.

13. The fecond genus of the firft order, occupied by acidiferous barites, affords but two fpecies, *fulphated barites,* and *carbonated*

barites

barites. In the hiftory of thefe fpecies, I have shewn the principal varieties they offer among thofe defcribed by Citizen Haüy ; and I have nothing to add here, except the general remark, that thefe two fpecies may be known among all the acidiferous fubftances nature prefents to us by means of their very confiderable fpecific gravity, and that one may be diftinguifhed from the other by the latter effervefcing brifkly with acids, which the former does not.

14. The third genus of the firft order is confined to the acidiferous ftrontian. On the firft publication of his mineralogy, Citizen Haüy mentioned only a fingle fpecies of this genus, for he knew no more ; namely, the *carbonated ftrontian,* or carbonate of ftrontian, which, approaching very near to the carbonated barites in fpecific gravity, and equally poffeffing the property of effervefcing with acids, was particularly diftinguifhable from it by the purple flame it gave with the blow-pipe. But naturalifts have fince difcovered a fulphate of ftrontian, which had been confounded with a fulphate of barites, and forms a fecond native fpecies of this genus : fo that ftrontian is exactly in the fame circumftances as barites, with refpect to the two different acids with which it is found combined among foffils. The fulphate of ftrontian is diftinguifhed from that of barites, to which it approaches in form and gravity, becaufe it is penetrated by expofure to a great

heat

heat with a purple-red phofphoric light, without, however, affording a phofphorus on being calcined with charcoal, as the latter does, which by being thus treated, forms the Bolognian phofphorus, of which I have fpoken when giving its hiftory.

15. The fourth genus of the fame order comprifes the acidiferous magnefia. We find in it but one fpecies, which Citizen Haüy mentions as unique; the *fulphated magnefia*, or fulphate of magnefia. In the article of this fulphate, I have faid all that is known of its foffil exiftence and mineral varieties. To this fpecies we muft add that of magnefia combined with the boracic acid, though it is truly in the form of a triple falt with lime, as already mentioned in the firft genus. We may be allowed to fufpect likewife, though no pofitive fact yet announces it, that magnefia exifts combined with carbonic acid in the bowels of the earth, and that it muft in this refpect refemble lime, barites, and ftrontian, which are there found united with the fame acid. But we ought not to be fatisfied with conjectures concerning nature, and cannot reckon this fpecies among natural productions, however probable may be its exiftence.

16. In the fecond order of this clafs of minerals, three genera are diftinguifhed; acidiferous pot-afh, foda, and ammonia. I fhall obferve, that it is not poffible to affign to each of thefe generic characters independent of
their

their chemical properties, and capable of point-
ing out their difference by their phyſical, ſen-
ſible, or external qualities: at leaſt to accom-
pliſh this, it is neceſſary to embrace ſuch a
number of qualities, that the mind is perplexed
in the choice and ſelection it is obliged to
make to diſtinguiſh each genus; which proves,
that method here requires the light of che-
miſtry for a guide, and that mineralogy is in
fact a branch of this ſcience, to which it will
approach ſo much the more in proportion to the
progreſs it makes in the art of claſſing mineral
productions.

17. The firſt genus of the ſecond order, or
acidiferous pot-aſh, contains but one ſpecies,
nitrated pot-aſh, or nitrate of pot-aſh, very
diſtinguiſhable among all the ſpecies of ſalts by
its detonation in the fire.

Acidiferous ſoda, or the ſecond genus, in-
cludes three ſpecies, 1ſt, *muriated ſoda*, or
muriate of ſoda, characterized by its cubic
form, and its ſalt taſte, and the only one of
the alkaline ſalts found in the earth in maſſes,
blocks, or veins; 2d, *borated ſoda*, or borate
of ſoda; 3d, *carbonated ſoda*, or carbonate
of ſoda. We are ſurpriſed at not finding in
this genus the *ſulphated ſoda*, or ſulphate of
ſoda, which ſo frequently ſhows itſelf in
effloreſcence on the walls of old buildings, and
in ſubterranean ſtructures; but it is certain that
this ſalt does not make a part of foſſils properly
ſo called.

The

The third and laſt genus of this order, acidiferous ammonia, is confined to a ſingle ſpecies; namely, *muriated ammonia*, or the muriate of ammonia, which is extracted from the neighbourhood of Volcanos, and frequently found ſublimed in their craters. Perhaps we ſhould add to this ſpecies that of ſulphated ammonia, or ſulphate of ammonia, which many naturaliſts affirm to be likewiſe met with among the ſublimed products of ſubterranean fires.

18. As to the third order of theſe native ſaline compounds, Citizen Haüy forms it of alkalino-earthy acidiferous ſubſtances; but as it contains only alum, under the name of *alkaline ſulphated alumine*, it ſhould ſeem unneceſſary to have made an entire order for the ſake of a ſingle ſpecies, or equally requiſite to form one for the magneſio-calcareous borate, ſince this likewiſe contains two baſes united at the ſame time to the boracic acid, namely, lime and magneſia.

19. Though theſe ſeventeen or eighteen ſpecies of ſaline or acidiferous compounds do not appear either ſo numerous, or ſo difficult to be characterized and diſtinguiſhed, as to require a multitude of explanations; Citizen Haüy yet muſt add to his general claſſification, of which I have given an account, as well as to that of the firſt claſs of ſtones, tables exhibiting the comparative properties of theſe bodies, which would ſerve to render his method complete.

The

The following exhibits the fyftematic claffifi-
cation and diftribution of thefe native falts.

SECOND CLASS.

Of Minerals.

Acidiferous Subftances.

ORDER I.

Earthy Acidiferous Subftances.

GENUS I.

Lime.

SPECIES I. *Carbonated Lime.*

II. *Phofphated Lime.*

III. *Fluated Lime.*

IV. *Borated Lime.*

V. *Sulphated Lime.*

GENUS

Genus II.

Barites.

Species I. *Sulphated Barites.*

II. *Carbonated Barites.*

Genus III.

Strontian.

Species I. *Sulphated Strontian.*

II. *Carbonated Strontian.*

Genus IV.

Magnesia.

Species I.

Sulphated Magnesia.

ORDER

ORDER II.

Alkaline Acidiferous Substances.

GENUS I.

Pot-Ash.

SPECIES I.

Nitrated Pot-Ash.

GENUS II.

Soda.

SPECIES I. *Muriated Soda.*

II. *Borated Soda.*

III. *Carbonated Soda.*

GENUS V.

Ammonia.

SPECIES I.

Muriated Ammonia.

ORDER III.

Alcalino-earthy acidiferous Subftances.

SINGLE SPECIES.

Alkaline Sulphated Alumine, or Alum.

20. ON reviewing the fmall number of fub-
ftances claffed in this table, and obferving the
methodical parade, and the divifion into orders,
genera, and fpecies, it is not eafy to avoid
feeling, that we might have difpenfed with
fuch a complex apparatus; as the few fubjects
it embraces, and the eafinefs with which they
may be diftinguifhed from each other, feem
not to require fuch a complication. It is per-
haps ftill more difficult to conceive, why it
has been thought neceffary to alter the che-

4   mical

mical nomenclature of falts, and run the rifk
in fome meafure of rendering its ufe in foreign
languages problematical; when, little occafion
appearing for creating a fyftem of claffification
for fuch a fmall number of natural productions,
it may be thought, that it would have been
fufficient to have borrowed from the fyftema-
tical chemifts the order already eftablifhed by
them among falts, which would have rendered
it unneceffary to follow the feries of their bafes
for their claffification.

Recourfe might have been had to this pecu-
liar mineralogical arrangement, if it had been
capable of furnifhing palpable, unequivocal,
and conftant external characters, fufficiently
numerous well to diftinguifh them. But as
this end cannot be attained, it feems a reafon
for not feeking a method different from that of
the chemifts, and rendering it neceffary to vary
the names given to thefe faline compounds,
without any ftriking advantage.

21. In fact, nothing can be more fimple,
than to felect from the numerous tribe of falts,
which we have made known, thofe fpecies that
conftitute a part of the foffils, or are found
among mineral productions; and to affign them
characters eafy to be diftinguifhed, which would
require no chemical trials, but fuch as the cheft
of the mineralogift, and the traveller always fur-
nifh the means of making: and the following
fketch will fhow, that it was apparently un-
neceffary to have overturned the method and
nomen-

nomenclature of chemifts for this purpofe. There are feven genera of falts, of which more or fewer fpecies are pretty frequently met with, and have been recognifed in the earth. Each of thefe genera, and their dependant fpecies, may be readily diftinguifhed by fome very ftriking properties, in the following manner.

22. GENUS I.

Sulphates.

Generic characters. They emit a fetid fmell of fulphur and fulphurated hidrogen gas, when they are heated with charcoal by the blow-pipe.

SPECIES I.

Sulphate of Barites.

Specific characters. Infoluble, cryftallized, infipid, affording Bolognian phofphorus on being calcined with charcoal.

SPECIES II.

Sulphate of Strontian.

Specific characters. Differing from the preceding by the purple phofphoric light it gives with the blow-pipe.

SPECIES

SPECIES III.

Sulphate of Lime.

Specific characters. Infipid; calcinable into plafter; foluble in five hundred times its weight of water.

SPECIES IV.

Sulphate of Soda.

Specific characters. Bitter and cool; melting at firft before the blow-pipe; very foluble; cryftallizable by cooling; efflorefcing in the air.

SPECIES V.

Sulphate of Magnefia.

Specific characters. Very bitter, very foluble; cryftallizable in fquare prifms; decompofable and precipitated by foda.

SPECIES VI.

Sulphate of Alumine and Pot-Afh; Alum.

Specific characters. Cryftallized in octahedra; of a ftyptic tafte.

GENUS

Genus II.

Nitrates.

Generic characters. They detonate on burning coals; give out oxigen gas when acted on by fire, and, after having been heated, a red vapour is expelled from them by concentrated sulphuric acid.

Species I.

Nitrate of Pot-Ash; Nitre.

Specific characters. A cool taste; easily cryftallizable in needles; fusible without drying; unalterable in the air.

Species II.

Nitrate of Lime.

Specific characters. Deliquescent, acrid, always moist or diffolved; precipitated by potafh, and the alkaline fulphates.

Genus

Genus III.

Muriates.

Generic character. Concentrated sulphuric acid expels their acid in a white vapour, and with its distinguishing smell.

Species I.

Muriate of Soda.

Specific characters. Salt taste; crystallization in cubes; decrepitation in the fire.

Species II.

Muriate of Lime.

Specific characters. Little crystallizable; very deliquescent; very bitter, and very acrid.

Species III.

Muriate of Magnesia.

Specific characters. Not crystallizable, deliquescent; precipitable by lime-water.

Genus IV.

Phosphates.

Generic characters. Fusible by a strong heat into enamel or glafs; decomposable by the acids, which feparate from them the phofphoric acid.

Species I.

Phosphate of Lime.

Specific characters. Infipid; infoluble; yielding a beautiful flame of a yellowifh green, when thrown in powder on burning coals.

Genus V.

Fluates.

Generic characters. Fusible into glafs; giving out with concentrated fulphuric acid a white vapour, which corrodes and takes off the polifh of glafs and quartz.

SPECIES I.

Fluate of Lime.

Specific characters. Cryftallizable in cubes; having an octahedron for its primitive form; giving a blueifh or greenifh flame on burning coals.

GENUS VI.

Borates.

Generic character. The boracic acid is extracted from them in fhining fcales by the fulphuric, nitric, muriatic, and phofphoric acids.

SPECIES I.

Borate of Lime, and Magnefia.

Specific characters. Of a cubic figure with the angles and edges fupplied by facets; oppofite electricity on two oppofite angles; hardnefs exceffive; infipid; infoluble.

SPECIES II.

Borate of Soda ; Borax.

Specific characters. Sapid and alkaline; foluble; cryftallizable in tetrahedral or hexahedral prifms.

GENUS VII.

Carbonates.

Generic character. Making with all the weak acids diluted in water, a brifk and continued effervefcence, owing to the evolution of carbonic acid.

SPECIES I.

Carbonate of Barites.

Specific character. Not parting with its acid in the fire but by the help of the charcoal with which it is calcined.

SPECIES II.

Carbonate of Strontian.

Specific character. Differing from the preceding by the light it gives with the blow-pipe.

C c 2

SPECIES III.

Carbonate of Lime.

Specific character. Yielding pure quick-lime by the action of fire.

SPECIES IV.

Carbonate of Soda.

Specific characters. Acrid taste; fpeedily and completely efflorefcing in the air.

SPECIES V.

Carbonate of Alumine.

Specific character. Infipid clay, diffolving gradually with effervefcence in hot acids.

ARTICLE XVIII.

Of the Salts which are found diffolved in Natural Waters, and of the Analyfis of Mineral Waters.

1. THE falts which nature affords, and which are difcovered among her productions, are not confined

confined to the dry, folid, or cryftalline form
of foffils. The greater part of thefe may be
found diffolved in waters alfo, which frequently
contain even fuch as do not occur in the folid
ftate. To complete our knowledge of them,
therefore, it is neceffary to examine the na-
ture of waters, the faline and foreign princi-
ples which they may contain, and which mi-
neralize them, their claffification founded on
thefe principles, and the art of diftinguifhing
or analyfing them, as alfo that of imitating
them.

2. It is eafy to conceive, that the waters
which defcend from the mountains, which
fwiftly rufhes down from them in torrents,
which flow in a body in rivers and ftreams,
and ftill more thofe which filtrate gradually
into fubterranean cavities, flowly traverfing the
ftrata of the earth, and, meeting with beds of
clay too thick for them to penetrate, re-appear
on the furface of the ground, where they form
fprings and brooks, muft diffolve in their paf-
fage the different faline matters which they
traverfe, or with which they come into contact,
according to their feveral degrees of folubility;
that they muft take up fo much the more, and
of fo much the greater number of fpecies, ac-
cording to the length of ground they traverfe,
and the time they remain on it; and that, ac-
cording to the variety of the faline ftrata they
penetrate, and the falts they find in their way,

many

many reciprocal actions and decompofitions muft take place in them.

3. The art of diftinguifhing thefe different falts diffolved by waters, and of eftimating their proportion, is one of the moft difficult tafks that can be propofed in chemiftry. It requires a perfect knowledge of the characteriftic properties of all faline fubftances, and accurate ideas of their reciprocal action, that we may not admit, as has often been done, the fimultaneous exiftence of falts which deftroy one another, and which cannot fubfift together in the fame folution. It requires great fagacity and extreme dexterity in the chemift, as well on account of the multiplicity of the principles exifting in thefe liquids, as of the fmall quantity of each of thofe diffolved in it. Frequently, according to the remark of Bergman, the fum of all the faline fubftances, diffolved in a mineral water, does not exceed a fix-thoufandth part of its weight, and yet it is found to be compofed of fix or eight different fubftances; fo that fome of them may probably not exceed an hundred thoufandth part of the water.

4. Though faline fubftances conftitute the moft frequent, the moft abundant, and the moft active mineralizing principles of waters, they are often accompanied with others, which muft be difcriminated at the fame time, and the prefence of which renders the nature and analyfis of thefe waters fingularly complex. We have reafon,

therefore,

therefore, to confider this branch of chemiftry as one of the moft difficult, and demanding in thofe, who make it their ftudy, the moft extenfive required knowledge, with the greateft refources of natural fagacity. Though I muft not pretend in this place to treat of mineral waters with all the minutenefs that would be requifite to give a due knowledge of the fubject in its whole extent, yet it is of fuch importance, and is calculated to give fo ufeful a recapitulation of the properties of faline fubftances, that I deem it highly neceffary to enter into fome methodical details for its explanation. Accordingly, under fix fucceffive heads, I fhall treat, 1. of the hiftory of the principal difcoveries that have been made refpecting mineral waters ; 2. of the faline matters formed in them, with a brief fketch of thofe not of a faline nature, which are met with in them at the fame time; 3. of the claffification of mineral waters according to thefe fubftances ; 4. of the re-agents by which they may be detected, and the means of employing thefe re-agents with advantage ; 5. of their analyfis by evaporation ; 6. of their fynthefis, or the artificial fabrication of mineral waters.

SECTION I.

Of the Periods of the Principal Difcoveries relative to Mineral Waters.

5. MEN firft diftinguifhed waters from one another by their tafte. Soon after, their different effects in the arts, and the occafions of life, led to a difcovery of their principal qualities ; though to what fubftances thefe quaties were owing remained long unknown. Hippocrates commended light, limpid waters, void of fmell and tafte: the hard, the brackifh, the aluminous, and thofe of lakes and ponds he rejected. Pliny diftinguifhed the nitrous, acidulous, brackifh, and aluminous waters, and thofe impregnated with fulphur, iron, or bitumen. He likewife divided them into falubrious, medicinal, poifonous, cold, warm, and hot. He reprobated thofe which would not boil pulfe, which left a coating on the veffels in which they were boiled, or which poffeffed an intoxicating property. To correct fuch waters as were of bad quality, he advifed them to be reduced to one half by boiling. But thefe notions, though tolerably accurate, were founded only on obfervation of the effects of waters, not on a knowledge of their principles. It is a ftriking feature in the hiftory of the human mind, that the ancients were totally ignorant of the art of decompofing bodies, and entirely

<div align="right">deftitute</div>

deftitute of the knowledge and inftruments of chemiftry.

6. Before the commencement of the feventeenth century we find nothing in the hiftory of chemiftry that has any relation to the art of analyzing waters.

In 1596, Andreas Baccius, the firft writer who treated profeffedly on waters, fays not a fingle word of experiments for decompofing them.

Tabernæ-Montanus, or John Theodofius, in his Enumeration of the Waters of Germany, about the fame period, is equally filent in this refpect.

In 1663, Boyle has fpoken of fome re-agents, and of their effects on waters, particularly with refpect to the action of acids and alkalis on blue vegetable colours. He was acquainted with the precipitation of folutions of filver and mercury by alkalis, and the muriatic acid; and the golden colour given to filver by fulphureous waters.

In 1665, Duclos undertook the analyfis of the mineral waters of France in the Academy of Sciences. He employed galls, fulphate of iron, and litmus, as re-agents; and began to examine the refidues of evaporated water.

In 1680, Urban Hierne publifhed fome Effays on the Waters of Sweden, which are by no means without merit. He particularly diftinguifhed the acidulous waters of Medvi, and brought them into ufe; and he made fome ufe-

ful

ful critical remarks on re-agents, which had begun to be employed.

In 1685, Boyle gave fome new inftructions for diftinguifhing the principles of waters ; propofing the ammoniacal fulphuret, or his *fuming liquor*, and folutions of nitre, fea falts, muriate of ammonia, acetite of lead, nitric acid, muriatic acid, and ammonia.

7. In the beginning of the eighteenth century the analyfis of waters made frefh advances. Regis and Didier employed mallow flowers to detect acids and alkalis ; Boulduc, lime-water ; Burlet, alum, and litmus paper. The proceffes of analyfis received great improvements. In 1707, Geoffroy fubftituted the evaporation of waters in fhallow glafs veffels inftead of their diftillation. In 1726 and 1727, Boulduc advifed the feparation of the fubftances depofited or cryftallized at different periods of the evaporation ; and the precipitation of waters by alcohol, to diftinguifh their nature, before evaporating them. From this period to the middle of the eighteenth century, the number of reagents ftill continued to be increafed ; but the conclufions drawn from their effects were long uncertain and erroneous.

8. During the periods quoted, the opinions entertained refpecting the principles of waters were very inaccurate. Paracelfus admitted among them a peculiar earth, and falts and metals in general. In 1699, Legivre attributed their acidulous quality to alum, the exiftence

of

of which in them was denied by Duclos; who
fufpected them to contain fulphate of lime,
which Allen firft demonftrated, under the name
of felenite, in 1711. In 1682, Hierne difco-
vered foda in them, which was called *nitre*;
and this difcovery was confirmed by Hoffman
and Boulduc. In 1682, Lifter found lime in
waters; Leroi, the muriate of lime in 1754;
Home, calcareous nitrate, in 1756; Margraff,
muriate of magnefia, in 1759; and Black made
known the true nature of fulphate of magnefia,
on which Grew had written a little work in
1696, and which was already known under the
name of *fal catharticus amarus*, bitter, purg-
ing falt, in the waters of Epfom, Egra, Sed-
litz, and Seidfchutz. The prefence of fulphate
of iron was long a fubject of difpute, which
fome afferted to exift in almoft all waters, and
to which others fubftituted a pretended fubtile
ore of iron, the foul of that metal, a volatile
vitriol, &c.

9. At the beginning of the feventeenth cen-
tury, gafeous waters excited no lefs difcuffion
among chemifts. Hoffman admitted in them a
volatile acid, eafily diffipated; at the fame time
he fuppofed them to contain alkali, which others
denied, becaufe they confidered this alkali as
neceffarily produced by fire. Henckel ima-
gined that this alkali was derived from fea falt,
without being able to explain how it loft its
acid. Doctor Seip, afcribing this acidity of
waters to a fulphurcous fpirit, which might be

<div align="right">obtained</div>

obtained from them by diftillation, explained their change in the air by the union of this with the alkali, which could take place only when the waters came into contact with it, and not in their fubterranean conduits. In 1748, Dr. Springfield confidered air as the caufe of the folution of faline and earthy principles in water, which principles were precipitated in proportion to the evaporation of the air. This opinion was ftrongly fupported in 1755 by Venel, who found, in addition, the means of imitating acidulous waters tolerably well, by diffolving alkaline carbonate in clofe veffels with the addition of an acid.

10. The difputes relative to thefe acidulous waters were terminated, and their nature made accurately known, by Black's difcovery of fixed air, or carbonic acid, and the fucceffive re-fearches of Bergman, Prieftley, Rouelle, Chaul-nes, Gioanetti, Citizen Guyton, &c. who in-ftructed us in the methods of diffolving this gafeous acid in water artificially, extracting it from water by different proceffes, and deter-mining its exact proportion; and taught us to confider it as the folvent of chalk, or carbonate of lime, of carbonate of magnefia, and of car-bonate of iron. This capital difcovery in che-miftry explained the reafon why acidulous wa-ters became turbid by expofure to the air, or by boiling; why they depofited ruft of iron at their furface in the channels through which
they

they ran ; and why they formed calcareous in-
cruſtations on bodies plunged into them.

11. Sulphureous waters, in which the exiſt-
ence of ſulphur was proved by a crowd of facts,
without chemiſts being able for a long time
to diſcover the cauſe of its ſolubility, became
known by the labours of Bayen, who, ſo early
as 1770, publiſhed the means of ſeparating it
from them ; of Monnet, who ſuſpected the va-
pour of liver of ſulphur to exiſt in them in
1768 ; of Bergman, who diſcovered in them
the gas of this compound, which he named
hepatic gas, in 1774 ; and of Rouelle, who ſoon
after confirmed the diſcovery of the celebrated
chemiſt of Upſal. I myſelf gave ſome very
ample details reſpecting ſulphureous waters, in
my Analyſis of the Waters of Enghien, pub-
liſhed in 1787, I ſhowed that the union of ſul-
phur and hidrogen was the true mineralizer
of that water ; and Mr. Giobert has ſince ex-
tended and confirmed that aſſertion in his well-
written Treatiſe on the Water of Vaudier,
printed in 1793. At preſent we have nothing
to learn on the ſubject of ſulphureous waters,
which are now as well known to us as the acidu-
lous.

12. Though the knowledge and accurate
analyſis of mineral waters cannot be conſidered
as truly acquired till within theſe late years,
ſeveral chemiſts have undertaken, at different
periods, to publiſh general treatiſes, more or
leſs complete, on theſe natural ſolutions of ſalts.

3   Wallerius,

Wallerius, in 1748, Cartheufer, in 1758, Monnet, in 1772, Bergman, in 1778, publifhed hydrologies, and methods of analyzing waters. There are befides a great number of monographic works on fome particular waters, which, on account of their merit, the great number of valuable details they exhibit, and the new data they prefent, ought to be efteemed as certain guides in the difficult art of making a chemical examination of thefe fluids. Thofe of Bergman on the Springs of Upfal, and the Waters of Danemarck ; of Black on feveral Waters of Iceland ; of Gioanetti on thofe of Courmayeur; of Giobert on the Water of Vaudier ; and, if I may be permitted to quote myfelf, that which I have publifhed on the Water of Enghien, particularly come under this defcription. Within thefe five-and-twenty years too the art of imitating mineral waters by artificial folutions, of different faline fubftances in pure water has been greatly improved. The differtations of Bergman on the recompofition of the waters of Seidfchutz, Seltzer, Spa, and Pyrmont, and the Art of Imitating Mineral Waters by Citizen Duchanoy, phyfician at Paris, muft be ranked in this clafs. They are the complement of the analyfis of waters, and atteft its progrefs.

SECTION

Section II.

Of the Saline Matters, and other Principles, which mineralize Waters.

13. THE numerous analyfes of mineral waters, made within thefe forty years, efpecially with fufficient exactnefs to determine their principles, have inftructed us, that the moft frequent and moft abundant mineralizers of thefe waters are to be found in the clafs of faline fubftances. On this account it is more natural to treat of thefe fluids immediately after the hiftory of falts, than in any other part of a methodical fyftem of chemiftry. Generally fpeaking, all that has been difcovered concerning thefe faline mineralizing principles of waters informs us, that the falts they hold in folution are to be found chiefly in the clafs of thofe that are termed foffil. There are, however, two remarkable reflections to be made on this fubject: the firft, that fuch foffil falts as are little, or not at all foluble, do not occur in mineral waters; the fecond, that fuch as are moft foluble, and particularly thofe that are of the deliquefcent kind, are never met with in the dry form, but always diffolved. It is fufficient to mention thefe facts in order to perceive that they are abfolutely dependent on the nature of things.

14. Among the fulphates we find, in waters, the fulphate of foda, which occurs particular-

ly

ly in fea-water, fprings, and brine-fprings; 2dly, fulphate of lime, which exifts chiefly in well-water, and is often the occafion of what is called *hardnefs* in waters; 3dly, fulphate of magnefia, which was firft obtained from fome mineral waters, and on this account called Ep-fom falt, Sedlitz falt, &c.; and which chiefly conftitutes purging waters; 4thly, the acid ful-phate of alumine and pot-afh, which is the moft rare of all, though formerly imagined very common: 5thly, the fulphates of barites and ftrontian have not been found in waters, though they are manifeftly depofited in cryftals from their native folutions, neither have the ful-phates of pot-afh, ammonia, &c.

15. No chemift has yet announced the pre-fence of any fulphite in mineral waters: it is not impoffible, however, that fome of thefe falts, particularly the fulphites of pot-afh, foda, and ammonia, may be met with hereafter in wa-ters in the neighbourhood of volcanos, fince thefe falts are frequently formed by the matters that exift there; but even were they diffolved in fuch waters, they would quickly pafs into the ftate of fulphates, by coming into con-tract with the air, and abforbing oxigen.

16. Though feveral fpecies of nitrates are very frequent on the furface of the earth, we rarely meet with them in mineral waters. However, we fometimes feparate from thefe, nitre, or nitrate of pot-afh, nitrate of lime, and nitrate of magnefia. Thefe falts exift chiefly

chiefly in pools, ponds, and lakes, where vegetable and animal matters are decompofed; as likewife in fome wells or refervoirs, the waters of which run through ground impregnated with thefe fubftances. They are extracted in particular from the lixivia of rubbifh worked by falt-petre manufacturers; and frequently two or three of them conftitute the greater part of the principles of thefe lixivia.

17. Of all the falts muriates are moft frequently and abundantly contained in mineral waters. We particularly find in them muriate of foda, muriates of lime and magnefia often accompanying the former, and much more feldom muriate of barites, which Bergman has pointed out in fome waters. ' The muriates of pot-afh, ammonia, ftrontian, alumine, &c. have not been difcovered in them. There is a confiderable number of waters, the nature and principal character of which are determined by the prefence of muriate of foda, and the large quantity of it which they contain.

18. Neither phofphates not fluates have yet been found diffolved in mineral waters. The earthy phofphates, and particularly the phofphate of lime, the only one met with among foffils, are in fact infoluble: befides, they are not very common. It cannot be doubted, however, that thefe falts, depofited in fparry laminæ, or in regular and tranfparent cryftals, conftituting apatite and chryfolite, have been

diffolved in water, and flowly feparated from the folution. As to the foluble alkaline phof-phates, fince they never exift in mineral ftrata, we cannot expect to find them in waters. Of the fluates the only one known in a foffil ftate, the fluate of lime, though evidently depofited from water, has never yet been found diffolved in mineral waters.

19. The fame may be faid of the borates. Borax, or the fuperfaturated borate of foda, which appears to exift native in fome of the waters of Perfia, India, China, and Japan, has notwithftanding never yet been detected among the mineralizing principles of waters. The magnefio-calcareous borates, fhows by its fitua-tion, its cryftallization, and its perfect or femi-tranfparency, that it owes its formation to water; yet in the waters in the vicinity of Lunen-burg, the only place where the borate called *cubic quartz* exifts, nothing has been found that indicates its prefence, or gives any light concerning its cryftallization and depofition.

20. The carbonates on the contrary are the moft frequent, and often the moft abundant of the falts that mineralize waters; as they are of thofe that are found in a folid form among the ftrata of foffils. It feems as if thefe com-pounds were thofe that coft nature leaft pains, and were fabricated by her with the greateft profufion. Though the carbonates of lime and magnefia are nearly infoluble, nothing is fo common as to find thefe two falts among the

mine-

mineralizing principles of waters. Indeed it must be confessed they are diffolved in them by means of the carbonic acid, which is diffipated by heat, or by contact with the air, and lets fall the two falts as it flies off in vapour. The carbonate of foda is met with in feveral waters, which have even been called alkaline on account of its prefence. It is very common for fuch waters to be at the fame time acidulous, or loaded with carbonic acid. Sometimes, but more rarely, the carbonate of ammonia is found in fmall quantity in certain waters, as thofe of pools or marfhes, where organic fubftances remain and putrefy.

21. I have pointed out the principal fpecies of falts, that have been detected in mineral waters. It is almoft fuperfluous to fay, that it is rare to find any containing only one fpecies of falt; that the number of thofe exifting together in them is never confiderable, and very feldom exceeds four or five; and that there are fome which mutually exclude each other, as fulphate of foda or magnefia, and the nitrate or muriate of lime, the calcareous falts, and carbonate of foda.

22. To the different faline fubftances which I have enumerated nature frequently adds other matters, belonging either to the clafs of burning bodies or fimple combuftibles, to that of acids, to that of metals, or to that of vegetables. Caloric, oxigen gas, atmofpheric air, fulphurated hidrogen gas, and even an

earthy

earthy or alkaline fulphuret, conftitute the firft. Oxigen gas, or atmofpheric air, cannot be found in them together with fulphurated hidrogen gas. It is not true, as was fome time thought, that metals, as fuch, in their ftate of purity, can ever be found in waters. Atmofpheric air renders waters light and brifk in their tafte and properties for domeftic ufe. Sulphurated hidrogen gas forms the greater part of fulphureous waters.

23. Of the acids none have yet been found pure diffolved in native waters, but the carbonic and boracic. The firft is much more common and abundant than the fecond: it is found united with many different and various falts, and by it many of thefe are rendered very foluble. The boracic acid, which has yet been difcovered only in certain waters of the lakes in Tufcany, is there united with but few different faline fuftances, and never conftitutes mineral waters properly fo called. No other acid has ever appeared uncombined in waters.

24. Of the earthy bafes only filex and alumine have yet been obtained from waters. The firft of thefe particularly, according to the experiments of Bergman and Black, appears to be contained in them in a proportion much greater than could ever have been imagined, or than the art of chemical folution by fimple water could ever have enabled us to conceive. It is owing to this, that we fee waters depofiting it by the contact of air, and by fpontaneous

neous evaporation, as those of the fountain of Geyfer in Iceland ; and hence we ought not to be furprized at finding filex conveyed into vegetables and animals, and forming concretions in them.

Alumine, which has been admitted as the caufe of the foapy quality in waters, is feldom more than fufpended in them, and gives them that turbid and milky appearance, by which they are eafily diftinguifhed.

Lime has been announced in fome waters in the neighbourhood of volcanos; but the affertion has not yet been confirmed by any accurate experiment. Befides, it cannot be applied to mineral waters properly fo called, fince no one of thofe ranked in this clafs has ever afforded any thing of the kind.

No perfon has ever met with any alkali, potafh or foda, barites or ftrontian, pure and unmixed in waters: and it is even eafy to conceive, that this cannot be, on account of the powerful affinity which thefe fubftances poffefs for a number of bodies.

25. The mineralizing principles of waters, exclufive of falts, are not confined to the matters treated in the three preceding claffes of faline fubftances. We find among them feveral metallic falts likewife, that is to fay, combinations of oxides of metals with acids; and fome of the matters that have belonged to vegetable compounds. It is more efpecially iron, that gives rife to the firft of thefe mineralizing

principles

principles of waters, which we find in them moft commonly united with carbonic acid, and fometimes, but much more feldom, with the fulphuric, or muriatic. Copper is found in them much more rarely in the ftate of fulphate, and forms thofe poifonous waters, which exift only in mines of this metal. The prefence of oxide, of arfenic too has even been announced in fome fubterraneous waters, running among ftrata of ores impregnated with this dangerous metal.

26. Laftly, colouring vegetable matters, or extracts of plants, and bitumens, have been reckoned among the ingredients of waters. Thefe extracts are found only in waters, where leaves, ftalks, barks, and even entire aquatic plants, lie and putrify; and thefe are not mineral waters properly fo called.

It is by no means uncommon, as will hereafter appear, for liquid bitumens to exude through fubterranean waters, and float on their furface, where they are collected: and it is not more unufual for fubterranean waters to pafs through veins of folid bitumen. It is obvious, that the fluid muft he more or lefs impregnated with bitumen, in either of thefe cafes. We do not ordinarily reckon thefe, however, among medicinal waters, or mineral waters properly fo called: and what in the latter was once termed the bitumen of waters, a product of evaporation, of an acrid, bitter, ftrong tafte, was a deliquefcent falt, almoft always muriate of lime.

Section III.

Of the Claſſification of Mineral Waters according to their Principles.

27. THOUGH among the foſſil productions that mineralize waters we reckon more ſaline ſubſtances than matters of a different nature, it is neverthelefs neceſſary to have regard to both in claſſing and dividing theſe natural fluids. A claſſification of waters is one of the moſt uſeful and important objects, that can be treated of in natural philoſophy. It enlightens all the ſciences, and all the arts reſpecting the employment of ſuch or ſuch a water: for it ought not to compriſe merely the waters uſed in phyſic under the name of medicinal, but likewiſe all thoſe, which, containing too ſmall a number of principles, or principles not ſufficiently potent, to have a ſpeedy and determinate or uſeful action on the animal economy, yet contain enough to produce ſome effects, not altogether indifferent in domeſtic uſes, or the proceſſes of art.

28. In this point of view, it will be uſeful to divide all native waters into two great claſſes: the firſt compriſing waters conſidered with reſpect to the places they occupy, the

bulk

bulk they prefent, and the manner in which they are placed on the furface of the globe. This clafs includes all waters ufed for domeftic purpofes or in the arts. To the fecond belong the lefs abundant waters, confined in fome degree to certain particular fpots of the globe, and diftinguifhed by much more ftriking effects on the animal economy. Thefe are the *medicinal waters*.

29. In the firft, or *economical* clafs, are ranked fnow, rain, fpring, river, well, lake, marfh, and fea-water.

Snow-water, according to Bergman, contains a little muriate of lime, and fome flight traces of calcareous nitrate. When frefh melted it is diftitute of air, and of carbonic acid, which are found in all the others; and to this probably are owing its difagreeable effects on animals.

Rain-water contains the two falts of the preceding in larger proportions. It is, befides, fufficiently impregnated with air, and with a little carbonic acid, which render it very ufeful to vegetation. The ancient chemifts ranked it with diftilled water: but it is evident that it is lefs pure, and it frequently contains four fubftances not found in water that has been diftilled. When rain-water is collected for chemical purpofes, the laft that falls fhould be taken.

Spring-water is very pure when it runs over fand. In other cafes, it moft frequently

<div align="right">contains</div>

contains carbonate of lime, calcareous muriate, muriate of foda, or carbonate of foda.

River-water is .frequently more pure than that of fprings ; its motion purifying it. The fame principles are found in it ; but frequently lefs abundant than in the preceding.

Well-water, almoft always remaining in faline foils, contains, befides the falts juft mentioned, fulphate of lime and nitrate of pot-afh : fo that there are almoft always five or fix falts in it at a time, and it is not eafy to make an accurate analyfis of it, when we would carry it fo far as to afcertain their proportions.

The water of *lakes* is lefs limpid and more heavy than the preceding. It frequently forms a fpontaneous depofition of earthy falts : and is often coloured, and of a difagreeable tafte. Befides the five or fix falts already mentioned, it almoft always contains extractive matter.

Marfh water, more ftagnant than any of the foregoing, is ftill lefs brifk, lefs limpid, more foul, and impregnated with ftill more of extractive matter, fo that it often has a yellowifh colour.

Laftly, *fea-water*, rendered falt as all the world knows, by the muriate of foda, which nature has placed in it, alfo contains fulphate of magnefia, fulphate of lime, and much extractive matter.

30. Mineral waters properly fo called, or rather medicinal waters, ought to be claffed according to the principle that predominates

in

in them. Confidered in this point of view,
they may be divided into four claffes, namely,
acidulous waters, faline waters, fulphureous
waters, and chalybeate waters. Though the
fecond only fhould feem to require to be treated
of here, as it is from the properties of falts
we have been led to their hiftory, it may not
be altogether ufelefs to fay a few words likewife
of thofe, which, though of another nature,
frequently contain fome falts.

CLASS THE FIRST.

Acidulous Waters.

THESE are waters in which carbonic acid
predominates. They are charaƈterized by their
poignancy, agitation, bubbles, the red colour
they give to litmus, and the precipitate they form
in folutions of barites, ftrontian, and lime.
None of them contain carbonic acid pure and
fimply: almoft all of them at the fame time
hold in folution muriate of foda, carbonate of
foda, carbonate of lime, carbonate of magnefia,
and often thefe four falts at once, as Seltzer
water. There are fome, too, in which iron is
found. Laftly, fome are warm, or thermal,
at the fame time that they are acidulous, as
thofe of Vichy, Mont-d'Or, Châtel-Guyon,
&c. ; and others are cold and alkaline, as thofe
of Myon, Bard, Langeac, Chateldon, Vals,
&c.

CLASS

CLASS THE SECOND.

Saline Waters.

THIS name I appropriate to thofe of which the predominant principles are falts properly fo called, and which in confequence belong more immediately to this fection than any of the others. They may at the fame time contain other matters, carbonic acid, fulphurated hidrogen gas, or iron : but thefe are in too fmall quantity, compared with the former, to be confidered as equal objects of attention.

This fecond clafs may be divided into five orders, according to the fpecies of falt which is predominant in the waters. If they be loaded with fulphate of lime, they conftitute *hard waters*, not pleafant to the tafte, incapable of diffolving foap, and unfit for boiling pulfe, fuch as the well waters of Paris.

When they contain fulphate of magnefia predominating over their other principles, they are *bitter* and *purgative*, as the waters of Sedlitz, Seidfchutz, Egra.

If it be muriate of foda which they contain in excefs, they are *falt*.

Carbonate of foda, when more copious than the other falts, forms *alkaline waters*.

Laftly, when they hold abundance of carbonate of lime; which is never diffolved in them without the exiftence of carbonic acid, but may be prefent without an excefs of it, and fo that the calcareous falt alone characterizes

terizes them; they form an *earthy* kind of *hard waters*, which more or lefs eafily depofit their infipid falt in ftalactites, or incruftations.

CLASS THE THIRD.

Sulphureous Waters.

THESE are clearly characterized, and eafy to be diftinguifhed by their fetid fmell, their property of gilding and blackening filver, and their depofiting fulphur when coming into contact with the air. They appear to form two orders : thofe which are impregnated only with fulphurated hidrogen, without an earthy or alkaline bafe, as are the majority of fulphureous waters ; and thofe which contain a true fulphur, as the waters of Bareges, Cautcrets, les Eaux-Bonnes, &c. apparently do. Moft of thefe waters, befides their fulphureous principle, contain falts, particularly alkaline and earthy muriates and fulphates.

CLASS THE FOURTH.

Chalybeate Waters.

IT will be feen in the following fection, that iron is fo abundant in the bowels of the earth, and fo frequently diffufed through its ftrata, that it becomes one of the moft ufual mineralizing principles of waters, and that of all mineral waters, the chalybeate are the moft common.

common. There is scarcely a country in which one or more of these springs will not be found. In these waters three orders should be distinguished according to the state of the iron contained in them. Either this metal is dissolved in them in the state of carbonate by the carbonic acid, but so that the latter is not in excess; and in this case they are simple chalybeate waters, as those of Forges, Aumale, and Condé: or the same carbonate of iron, dissolved by its acid, is accompanied by a great excess of the latter; and then they are acidulous chalybeate waters, as those of Spa, Pyrmont, Pougues, Bussang, &c.; or lastly, the iron is contained in them in the state of sulphate, as it appears to be in those of Passy, Provins, &c.

31. To these four classes, comprising ten orders of mineral waters properly so called, or sufficiently impregnated with salts and fossil substances to possess medicinal properties, some authors further add, 1st, *simple thermal* waters, or waters naturally hot, without containing any principle beside caloric; 2dly, *saponaceous waters*, which are said to contain argil or alumine, by which they are rendered soft and unctuous, but the nature and existence of which have not been established by experiments sufficiently decisive; 3dly, *bituminous waters*, the composition of which is not more accurately confirmed than that of the preceding, and which, besides, are not included among waters

4 truly

truly medicinal. I say nothing likewise of cupreous and arsenical waters, because they do not rank with the preceding, they exist only in mines by which they are produced, and they will be treated of with more propriety in the history of metals.

SECTION IV.

Of the Examination of Waters by Re-agents.

32. THERE are three methods of discovering the nature of waters. The first is calculated to give only a vague and general notion of the principles that predominate in them; consisting in the collective mass of physical observations that may be made on waters, on their source, their depositions, their efflorescence, and the soils in their vicinity. The second carries us further into the knowledge of their component parts : enabling us to appreciate their principles, their differences, their number, and even to a certain degree their proportion. To obtain this knowledge, the waters are examined by adding different matters to them, and the alterations produced by this mixture, indicate what the fluids contained. The matters thus added are termed re-agents. The third method is the only one that enables us to determine the true principles of waters with precision, and is the complement of the two former.

former. This is the action of fire, which separates from water the different substances contained in it. We will begin by pointing out the first and second methods in the present division: the third, fertile in facts, and of great importance to be known, shall form the subject of the following.

33. The observation and comparison of the physical characters or properties of waters, and of every thing around their sources, are in fact, but accessary means, and ought to precede all those, that are usually employed for the investigation of these fluids. Among these we include the situation of the spring, the nature of the soil whence it issues, the strata of minerals that form this soil, the depositions at the bottom of springs and rivulets, the incrustations on substances that fall into them, the filaments and pulverulent or slimy clots met with in them, the pellicles with which the water is covered, the sublimates attached to the vaults over it, and likewise the taste, smell, colour, specific gravity, temperature, quantity, course, rapidity, or depth of the water. We ought even to vary the times of these observations, and to compare them at different seasons of the year, and at different hours of the day. It is impossible but these preliminary researches must afford us some positive idea of the nature of the water, and serve to guide us in the experiments to be chosen afterward for giving us a more accurate knowledge of it.

34. From

34. From what has already been faid of re-agents in general, it may be conceived, that all chemical fubftances, whatever be their nature, provided their properties and compofition be well known, may ferve as re-agents, and that even no compound is ufelefs to an able and induftrious chemift in his analyfis. But by long fearch, we have learned to make a choice of fome leading fubftances, the effects of which being compared are fufficient to point out the different principles that exift in waters. In treating of mineral waters in particular therefore, it is neceffary to point out thofe re-agents, by the help of which we are accuftomed to examine them. They are in general of two claffes: they either belong to the genera of fubftances already noticed in the preceding fections; or are taken from different fections, either from among the folutions of metals, or from matters which conftitute the bodies of vegetables and animals, or which are obtained from them.

36. Two circumftances that complicate or vary the effects of re-agents, muft render their ufe more difficult, and require great circum-fpection on the part of chemifts. One is, that the fame fubftance ufed as a re-agent, fometimes produces a fimilar apparent effect on two, three, or more different matters contained in waters: the other, that one re-agent may produce feveral of thofe effects in the fame water. Both thefe inconveniences, however, are remedied, by employ-

employing and comparing the effects of feveral of thefe re-agents, and examining the precipitate formed by them. This method of proceeding, the only one that can render the ufe of re-agents much more certain and advantageous, fuppofes that we do not precifely fix their number, which ought to have no limits but the induftry or knowledge of the chemift; and that we do not content ourfelves with adding a few drops to a fmall quantity of water, but that we treat this water with re-agents in the large way, if it be neceffary, fo as to obtain a quantity of precipitate fufficient for an accurate analyfis.

36. The re-agents taken from the claffes of fubftances already examined, belong either to burned bodies and acids, to alkaline or earthy bafes, or to falts. Among the acids, thofe which are moft frequently and moft fuccefsfully employed for examining waters, are the fulphuric, the fulphureous, the nitrous, and the oxigenated muriatic.

The firft announces the prefence of barites in waters by the heavy and copious precipitate it forms; and that of carbonic acid, or of earthy or alkaline carbonates, by the effervefcence it produces.

The fulphureous acid fhows fulphur as a white precipitate remaining a long time fufpended in waters, which contain it in the ftate of fulphurated hidrogen.

The nitrous produces the fame effect, and deftroys the fetid fmell of thefe waters, feparating

the fulphur in a white powder, which collects into fmall globules, on being expofed to the action of heat.

The oxigenated muriatic acid ferves for the fame purpofe by decompofing the fulphurated hidrogen. It frequently happens, that this acid burns the fulphur at the fame time with the hidrogen, when it is employed in too large a quantity.

37. The earthy or alkaline bafes moft employed as re-agents are three in number : lime, pot-afh, and ammonia, all in a ftate of folution. Lime-water abforbs carbonic acid, and precipitates with it in chalk, the weight of which indicates that of the acid : it likewife decompofes the carbonate of foda it meets with, precipitating carbonate of lime : laftly, it takes the acids from magnefia, which it precipitates in little whitifh clouds, that flowly condenfe. This triple effect, which may take place at the fame time, would then require an examination of the precipitate formed : the proportions of the carbonate of lime and of the magnefia, and the examination of the liquor, would afcertain the relations and co-exiftence of each effect ; but with too much difficulty for lime-water to be truly ufeful, except in one of the cafes mentioned, particularly for appreciating the quantity of carbonic acid contained in the mineral water. To diftinguifh the acid belonging to the carbonate of foda from what was free in the water, an equal quantity of the liquid muft be precipitated, after it has been

2   de-

deprived of the free acid by long boiling, and the weight then obtained muft be fubtracted from the fum total of that before produced in the water unboiled.

38. Pure liquid pot-afh produces feveral fimultaneous effects in waters. It decompofes the fulphates, nitrates, and muriates of lime and magnefia, and feparates their earths at the fame time : it precipitates the carbonates of lime and magnefia, diffolved by means of the carbonic acid, which it abforbs: when it is thoroughly concentrated, it even renders turbid, waters containing alkaline falts, becaufe it diminifhes their folubility by the attraction it exerts on the water. This laft effect is afcertained by adding more water, as this re-diffolves the precipitate, which was, befides, in fmall cryftals. The calcareous and magnefian earths diffolve in acids without effervefcence : the earthy carbonates, feparated by the abforption of the carbonic acid, unite with it on the contrary, with a brifk effervefcence. The metallic falts are likewife decompofed and precipitated by pot-afh : but the colour, form, and whole appearance of the oxides, particularly of that of iron, when once feparated, render them eafily known.

39. Ammonia decompofes only the magnefian and aluminous falts that may occur in waters : it likewife precipitates the former only in part, producing triple falts with the portion which remains undecompofed. It feparates alfo the carbonates of lime and of magnefia

that are diffolved by the carbonic acid, this acid being abforbed by it. It does the fame with the carbonate of iron, when in like manner diffolved by this acid: but it acts particularly on cupreous falts, and efpecially on the fulphate of copper, which is found in fome waters. Thefe cupreous folutions are made by it to affume a blue colour, which very readily detects their nature, and the prefence of the metal by which they are mineralized. This volatile alkali is fcarcely ever ufed as a re-agent, becaufe its effects are not very fenfible, becaufe it is lefs ufeful than lime-water, and becaufe the precipitate it gives, unlefs it be a metallic oxide, is difficult to determine, though it is almoft always incomplete, and yet mixed with feveral different fubftances.

40. In the fection of falts there are only the earthy muriates, and alkaline carbonates, which can have any advantage as re-agents. The muriate of barites ferves to detect fulphates, and even the quantity of fulphuric acid contained in a water, from the weight of the fulphate of barites obtained. The muriate of lime precipitates alkaline fulphates in a calcareous fulphate. The alkaline carbonates, which were formerly employed as alkalis, to detect and precipitate earthy falts, at a time when only thofe with bafes of abforbent earth were known, do nothing more than afcertain their prefence in general, by precipitating together thofe with bafes of barites, ftrontian, lime, magnefia, and alumine. It is very difficult to know exactly the effects, often
numerous,

numerous, which they produce, unlefs we particularly examine the precipitates they form.

I have faid, that the re-agents not included among the fubftances treated of hitherto, belong either to the folutions of metals, or organic compounds.

41. As to the metallic falts there are two in particular, nitrate of mercury and nitrate of filver, which are univerfally employed for analyzing waters, and which offer accurate information of their nature. Both unequivocally announce the prefence of fulphuric acid, and of muriatic acid, without indicating the bafes however, to which thefe acids are united. In the hiftory of the two metals, with which thefe folutions are prepared, what will be faid of their nitrates will render our knowledge of the action of thefe metallic falts or waters much more precife, much more complete, and confequently much more clear. It will be feen likewife, in the following fections, that a great number of other metallic falts may be employed by chemifts for attaining a knowledge of the principles of mineral waters.

42. Vegetables afford, for the analyfis of waters, three or four very ufeful colouring matters, two acids, and a metallic falt, the action of which is very advantageous in this kind of analyfis. Litmus, which is reddened by the hidrofulphuret and the carbonic acid of waters, and which in the latter cafe lofes its rednefs by expofure to the air, which takes from it the carbonic acid; the tincture of violets, which is

turned

turned green by the carbonates of foda and lime, as well as by the falts of iron; paper ftained yellow by turmeric, which alkaline fubftances, and even the light and earthy, change to a violet purple; and the faint blueifh or reddifh tinge of mallows, which is rendered a fine green by the fame fubftances, are four re-agents ufed with fuccefs for difcovering the prefence of the fubftances here enumerated.

The oxalic acid, either natural, extracted from the falt of wood-forrel, or artificially prepared as will be fhown, with fugar and nitric acid, announces with certainty, lime, which it takes from all other acids, and with which it forms an infoluble falt, the precipitate of which is perceptible when it is ufed in the fmalleft quantity.

Gallic acid indicates in waters the prefence of iron, by the colour of red wine, or the black inky precipitate which it occafions. If it produce neither of thefe effects, we may be certain the water contains no iron.

The acetite of lead is blackened by hidrofulphuret, precipitated in fmall white infoluble grains by all the fulphates, and in a heavy white powder, foluble in vinegar, by all the muriates. Alkaline or earthy carbonates in waters, likewife precipitate the acetite of lead.

Alcohol and vinegar are often ufeful in the analyfis of waters, but rather as folvents of fome of their principles, as will appear below, than as re-agents.

43. Ani-

43. Animal fubftances were formerly much employed for analyzing waters. Blood, milk, bile, were mixed with them, and from their action on thefe fluids, the effects they would produce on living animals were inferred. But thefe ridiculous inferences have long been rejected as dangerous errors. At prefent nothing of this kind is employed for the analyfis of waters but a chemical compound, made of animal fubftances, treated with two of the fixed alkalis. This compound, the defcription of which cannot be given with propriety in this place, is named pruffiate of pot-afh, or of foda, becaufe, when it meets with iron in any water, it lays hold of it, and precipitates it in a fine blue colour, called Pruffian blue. Particular mention will be made of it in the eighth fection of this work.

Section V.

Of the Analyfis of Waters by Evaporation.

44. WHATEVER care we take in the employment of re-agents, they are not fufficient to fhow with accuracy the number and proportions of the falts, or other matters contained in mineral waters: they give us only preliminary ideas, calculated to guide us in the other proceffes, which fhould afterwards be adopted. Thofe to which we have recourfe for completing the analyfis of a water, require the employment of fire, or evaporation. In expofing mineral waters to heat, we have two objects in view: the one, to collect the volatile matters that may exift in them,

them, the other, to obtain feparately and in a folid form, the fixed and faline fubftances, which conftitute their mineralizing principles.

45. To feparate the gafes, the carbonic acid, fulphurated hidrogen gas, or atmofpheric air, which may be diffolved, one or other of them in a water, it is diftilled in a retort in the quantity of a few pints or pounds, a jar filled with mercury being adapted to the neck of the retort. The water is boiled a few minutes, till nothing more is extricated from it: the quantity of air which was contained over the water in the retort, is fubtracted from the gas obtained: the increafe or diminution of the preffure on the gas collected in the jar is taken into account, in order to calculate its quantity with precifion; and it is examined by the known proceffes. To this diftillation, however, which never gives the exact quantity of the gas, I prefer its abforption or deftruction by re-agents, as lime-water for carbonic acid, oxide of lead or nitrous acid for fulphurated hidrogen gas, and fulphate of iron for atmofpheric air.

46. The evaporation intended to collect the falts or fixed matters, fhould be employed on fifteen or twenty pounds, at leaft of waters the moft loaded with principles, and on three or four times as much for waters that contain little. It fhould be conducted in veffels of filver, earth, or porcelain, with a moderate heat, and excluding duft by means of a lid pierced with holes, or a piece of gauze doubled. Formerly, the evaporation was performed at feveral times, and the

various

various fubftances were feparated at the different times at which they made their appearance. At prefent we have found, that this feparation is neither accurate nor advantageous; and it is admitted to be much better, to evaporate waters to drynefs fo as to obtain the refiduum entire. Great care is taken to moderate the heat toward the end of the evaporation: the matter that is left is moderately dried, weighed with care, and referved to be treated in the following manner.

47. Experience having fhown, that this refiduum of the evaporation of mineral waters was compofed of deliquefcent falts, of falts fimply foluble in cold water, of other falts foluble in a large quantity of boiling water, and laftly of matters infoluble in water at any temperature: the art of analyzing the refiduum has been founded on this knowledge.

It is treated firft with five or fix times its weight of highly rectified alcohol, which is flightly heated, and left to ftand on it fome hours. This menftruum being poured off, the refiduum is found to have loft its deliquefcent property.

In the fecond place it is lixiviated with eight or ten times its weight of cold water, which diffolves the alkaline falts.

The refiduum left by thefe two folvents, is boiled in three or four hundred times its weight of water, which takes up the leaft foluble falts.

Laftly, as a final analyfis, acids of different ftrengths are fucceffively employed, the weakeft firft, to feparate and difcover the infoluble
earthy

earthy falts, metallic oxide, and filex, which frequently remain mixed after the action of the other three menftrua. Each of thefe lixivia is then examined feparately.

48. The alcohol folution moft frequently contains muriates of lime and magnefia, and but rarely nitrates of the fame bafes, all which falts are deliquefcent, and foluble in alcohol. Thefe are detected, and their proportions determined, by evaporating the folution to drynefs; re-diffolving the falts in water, after having weighed them with accuracy, and precipitating the magnefia by lime, and the lime by fulphuric or oxalic acid. To obtain an accurate refult, the aqueous folution may be feparated into three equal parts, and one of them decompofed by lime-water, which will give the quantity of magnefia by tripleing the weight of what is obtained; a fecond precipitated by the oxalic acid, and the third by the fulphuric: on comparing the quantities of thefe two precipitates, and calcining the oxalate, which will leave only pure lime, the exact weight of the lime will be found. The acid united to thefe bafes may be afcertained by pouring a little concentrated fulphuric acid on a fmall portion of the refiduum obtained by evaporating the alcohol. The vapour, difengaged, will eafily diftinguifh whether it be the muriatic acid or the nitric.

49. The lixivium, in cold water, contains very foluble falts; muriate of foda, fulphate of foda, fulphate of magnefia, nitrate of pot-afh, or carbonate of foda, never all of them at once,

<div align="right">but</div>

but fometimes two or three together. It muft be obferved, however, that a little muriate of foda, or nitrate of pot-afh, will have been diffolved in the alcohol with the deliquefcent falts, but that this fmall portion may be feparated and obtained by evaporation. The falts diffolved in this aqueous lixivium, are difcovered and feparated by cautious evaporation : they are obtained fucceffively one after another, and are diftinguifhed by their figure, tafte, and other properties.

50. In the lixivium made with boiling water there is never any thing but fulphate of lime, which is detected, and its quantity at the fame time determined by oxalic acid, which precipitates the lime, and by a folution of barites, which takes from it the fulphuric acid. It may be obtained likewife by evaporation in the form of little fcales, infipid and infoluble, which, being heated with charcoal, afford a fulphuret of lime, of a reddifh colour, and emitting a fetid fmell the inftant it is thrown into water.

51. The refiduum of the mineral waters treated by the three preceding menftrua, contains earthy carbonates, with or without carbonate of iron, and often mingled with alumine and filex. The prefence of iron may be known by a yellow or reddifh colour. In this cafe the refiduum is to be wetted, and expofed to the fun and air for fome days, in order to oxidate the iron, and render it infoluble in acetous acid, which is firft to be employed for diffolving the earthy carbonates. This firft
folution,

folution, which commonly forms acetites of lime and magnefia, is to be evaporated to dry-nefs; and on leaving the falt thus obtained in a ftate of expofure to the air, the magnefian acetite will abforb its humidity, and may be feparated from the calcareous acetite by means of this deliquefcence. They may likewife be fubjected to all the modes of trial neceffary to afcertain their proportions.

The iron and alumine being afterward dif-folved by the muriatic acid, they are to be feparated, and their refpective quantities afcertained, by the appropriate methods. Nothing then will remain but the filex, to put the exift-ence of which beyond a doubt, it is to be treated with carbonate of foda by the blow-pipe, when it will fufe with effervefcence into a tranfparent vitreous globule.

SECTION VI.

Of the Synthefis, or Artificial Fabrication of Mineral Waters.

52. A CHEMICAL analyfis has long been confidered as well executed, when by the aid of fynthefis we can re-compofe the matter ana-lyzed. This truth is applicable to mineral waters, though the fynthefis of thefe is to be claffed among the number of things that have been difcovered within a few years. In fact, we fhould not depend on the accuracy of an analyfis of a water till we have made an exact imitation of it by diffolving in the pure fluid
the

the fame principles as we had difcovered, and in the fame proportions, fo that this imitation fhall exhibit the fame appearances on every trial, and with every re-agent, as the natural water.

53. Since the difcoveries of the carbonic acid, and the great variety of faline fubftances, we have fucceeded fo well in making accurate analyfes of mineral waters, and confequently in re-compofing them, that it has given birth to a new art of no fmall importance to man-kind, as it is employed in the preparation of medicaments appropriated to a confiderable number of difeafes. For this purpofe the firft thing to be done is to choofe very pure fpring or river water, which contains little or no fo-reign matter: in this, carbonic acid is to be diffolved, if for an acidulous water, and then the falts which analyfis has fhown the water we would imitate to contain. If it be a chaly-beate water we would fabricate, iron is to be added.

54. When we would prepare fulphureous wa-ters, we faturate water well boiled and deprived of its air, with fulphurated hidrogen gas, dif-engaged from alkaline fulphuret, or fulphuret of iron, on which, previoufly reduced to powder, is to be poured fulphuric or muriatic acid dilu-ted in water. When this water is fo faturated by means of gentle agitation, the falts or fixed matters we know to be contained in it are to be introduced. In this imitation we do not em-ploy the inert fubftances, as the carbonate and

fulphate

fulphate of lime, which are found in the natu‑ ral water we would imitate; we admit only the active fapid falts, which are taken in a pure and cryftallized ftate. We may even employ them in greater quantity than the natural water contains, and thus prepare waters of greater ftrength, and more penetrating, than thofe we would imitate.

55. Bergman has given the means of thus imitating the waters of Seidfchutz, Seltzer, Spa, Pyrmont, St. Charles in Bohemia, and Aix-la-Chapelle. The following are the principles, which, conformably to his analyfis, he propofes to be diffolved, to imitate each of thefe mineral waters, moft of which, in fact, are in high repute. In this table I fhall firft give the quantity of the principles in grains, proportioned thus by Bergman to a quantity of water alfo eftimated in grains, and then their proportions in decimal fractions, or in thoufandth parts of the water containing them.

SEIDSCHUTZ WATER.

Weight - - - - -	$= 17991 \frac{17}{32}$ grains	$= 1000$
Specific gravity - -	$= 1,0060$	
Pure air - - - - - -	$= \frac{43}{108}$ cubic inches	$= 0,011$
Carbonic acid - . -	$= \frac{45}{103}$ cubic inches	$= 0,015$
Carbonate of lime - -	$= 1 \frac{19}{21}$ grains -	$= 0,106$
Sulphate of lime - -	$= 5 \frac{5}{52}$ grains - -	$= 0,294$
Carbonate of magnefia	$= 10 \frac{3}{8}$ grains - -	$= 0,577$
Sulphate of magnefia -	$= 363 \frac{13}{16}$ grains -	$= 20,812$
Muriate of magnefia -	$= 7 \frac{5}{14}$ grains - -	$= 0,512$

SELTZER

SELTZER WATER.

Weight - - - - = 17932 $\frac{17}{3\frac{1}{2}}$ grains -	= 1000
Specific gravity - - - = 1,0027	
Pure air - - - - - = $\frac{43}{108}$ cubic inches	= 0,011
Carbonic acid - - - = 24 cubic inches	= 0,910
Carbonate of lime - - = 7 $\frac{3}{3\frac{1}{2}}$ grains -	= 0,396
Carbonate of magnefia = 12 $\frac{1}{2}$ grains -	= 0,697
Carbonate of foda - - = 10 $\frac{5}{3\frac{1}{2}}$ grains -	= 0,566
Muriate of foda - - - = 46 $\frac{11}{3\frac{1}{2}}$ grains -	= 2,684

SPA WATER.

Weight - - - - = 17902 $\frac{1}{8}$ grains -	= 1000
Specific gravity - - - = 1,0010	
Carbonic acid - - - = 18 cubic inches	= 0,684
Carbonate of lime - - = 3 $\frac{19}{3\frac{1}{2}}$ grains -	= 0,201
Carbonate of magnefia = 8 $\frac{7}{15}$ grains -	= 0,479
Carbonate of foda - - = 3 $\frac{19}{3\frac{1}{2}}$ grains -	= 0,201
Carbonate of iron - - = 1 $\frac{3}{0}$ grains -	= 0,077
Muriate of foda. - - = $\frac{8}{19}$ grains -	= 0,023

PYRMONT WATER.

Weight - - - = 17927 $\frac{2}{13}$ grains	= 1000
Specific gravity - - - = 1,0024	
Carbonic acid - - - = 37 $\frac{2}{3}$ cubic inch.	= 1,429
Carbonate of lime - - = 8 $\frac{7}{15}$ grains -	= 0,473
Carbonate of magnefia = 19 $\frac{1}{20}$ grains -	= 1,063
Carbonate of iron - - = 1 $\frac{3}{}$ grains -	= 0,077
Sulphate of lime - - = 16 $\frac{3}{10}$ grains -	= 0,909
Sulphate of magnefia - = 10 $\frac{3}{8}$ grains -	= 0,579
Muriate of foda - - - = 2 $\frac{31}{3\frac{1}{2}}$ grains -	= 0,165

WATER of ST. CHARLES in BOHEMIA.

Heat 58 $\frac{2}{5}$

Weight - - - - - = 17900 grains -	= 1000
Specific gravity - - - =	

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Sulphurated hidrogen gas = 24 cubic inches = 0,442
Carbonate of lime - - = $10 \frac{5}{32}$ grains - = 0,568
Carbonate of foda - - = $28 \frac{3}{8}$ grains - = 1,585
Sulphur - - - - - = $3 \frac{7}{19}$ grains - = 0,188
Sulphate of foda - - = $100 \frac{1}{8}$ grains - = 5,593

WATER OF AIX-LA-CHAPELLE.

Heat $49 \frac{3}{5}$

Weight - - - - - = 17897 grains - = 1000
Specific gravity - - - =
Sulphurated hidrogen gas = 24 cubic inches = 0,443
Carbonate of lime - - = $11 \frac{13}{32}$ grains - = 0,638
Carbonate of foda - - = $29 \frac{5}{8}$ grains - - = 1,655
Sulphur - - - - - = $3 \frac{7}{19}$ grains - = 0,188
Muriate of foda - - - = $12 \frac{9}{32}$ grains - = 0,692

56. Lately, art has gained much in the imitation of mineral waters, particularly of thofe which are impregnated with elaftic fluids, and are indebted to thefe for their virtues. By the help of machines, exerting great preffure, water is made to imbibe four, five, or even fix times its bulk of carbonic acid, fo that art thus impregnates it with more than nature does. The fame is effected with fulphurated hidrogen gas, and even with oxigen gas; and there is reafon to prefume, that by this procefs will be formed a new Materia Medica, derived from the properties of elaftic fluids.

END OF THE FOURTH VOLUME.